

REPORT
OF
THE HINDI TYPEWRITER
AND
TELEPRINTER COMMITTEE

ED. 205
1500

PART—I
(HINDI TYPEWRITER KEYBOARD)



MINISTRY OF EDUCATION : GOVERNMENT OF INDIA
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54	1	54	52
55	1	55	53
56	1	56	54
57	1	57	55
58	1	58	56
49	Last	49	57
50	1	50	58

CONTENTS

CHAPTERS	Pages
INTRODUCTION	1
I General Considerations	3
II Characters Selected for the Keyboard	6
III Arrangement of Keys and their Relative Propitiousness	12
IV Movement of Keys	17
V Positioning of Characters on the Keyboard.	19
VI Alignment of Characters	32
VII Incorporation of the International and Devanagiri Forms of Numerals in the Same Keyboard	40
APPENDICES	
A Devanagiri Characters Standardised by the Lucknow Conference	44
B Frequency Percentage Chart	45
C Consonants Included in the Keyboard	47
D Characters Finally Included in the Keyboard	48
E —I Proposed Arrangement of Keys of the Standard Typewriter Keyboard (46 Keys Trapeze Design)	49
II Conventional Arrangement of Keys in a Standard Typewriter Keyboard with 46 Keys	50
III Proposed Arrangement of Keys for a Standard Typewriter with 45 Keys	51
IV Proposed Arrangement of Keys for a Portable or Standard Typewriter with 44 Keys	52
V Proposed Arrangement of Keys for a Portable Typewriter with 43 Keys	53
VI Proposed Arrangement of Keys for a Portable Typewriter with 42 Keys	54
F Chart Showing Operation of Keys by Different Fingers of the Two Hands	55
G Chart Showing the Relative Propitiousness of Keys on the Proposed Keyboard	56
H Chart Showing the Total Frequency of Devanagiri Characters Selected for the Hindi Typewriter Keyboard	57
I Finalised Keyboard for the Standard Hindi Typewriter-46 Keys	59
J Finalised Keyboard for the Standard Hindi Typewriter-42 Keys	60
K Chart showing the positioning of Alignment of vowels, full and half consonants, matras and certain other signs and symbols included in the Hindi Typewriter Keyboard	61



PART I

Hindi Typewriter Keyboard

INTRODUCTION

In accordance with the decision of the Cabinet (vide Cabinet Memo No. 1/CM/55 dated 8.1.1955), the Ministry of Education was directed to set up a Committee consisting of a representative of the Directorate General, Posts & Telegraphs, a representative of the office of the Chief Controller of Printing & Stationery and a representative of the Ministry of Education to finalise standard keyboards for the Hindi typewriter and teleprinter in accordance with the recommendations of the Lucknow Conference on Devanagari Script Reform, held in November, 1953. A special Committee was accordingly set up by the Ministry of Education in February, 1955, with the following members:—

1. Shri S.M. Agarwal,
Director of Phones,
Directorate General, Posts & Telegraphs,
Ministry of Communications,
Government of India,
New Delhi.
2. Shri A.C. Sen,
Controller of Printing,
Office of the chief controller of
Printing and Stationery,
Ministry of Works, Housing & Supply,
Government of India,
New Delhi.
3. Dr. Yadu Vanshi,
Special Officer (Hindi),
Ministry of Education,
Government of India,
New Delhi.

The Committee started functioning from the 4th March, 1955. It made a detailed examination of the Devanagari characters which have been finalised as a result of the recommendations made by the Lucknow Conference, the manner in which these characters would be incorporated in the keyboards of the Hindi typewriter and teleprinter, and the particular position on these keyboards which each character should occupy. The limit imposed by the maximum number of keys which can be incorporated on a typewriter or teleprinter keyboard, the relative propitiousness (i.e., ease in operation of each individual key), the frequency of occurrence of each letter and half-letter, were all examined in detail. The existing literature on the subject was studied. Most of the existing makes of typewriters and the existing English teleprinters available were also examined. Reports from bodies and individuals who had worked on the subject and reports submitted by certain manufacturing companies on the special features of their machines were also examined. The Committee conducted a number of tests under its direct supervision to determine the relative propitiousness of the keys. The Committee also went into some detail regarding the principles underlying the arrangement of letters on standard typewriters and teleprinters of languages other than Hindi.

Based on the results of this detailed study and examination, the Committee has come to certain conclusions on the basis of which it has proceeded to standardise the layouts of Hindi typewriter and teleprinter keyboards.

In this work speed and accuracy in typing and ease of operation have been the main guiding principles of the Committee.

The Committee had also the good fortune on several occasions of having personal discussions with the Union Home Minister, Pandit Govind Vallabh Pant, who had been closely associated with the Lucknow Conference. On one occasion, Shri Sampurnananda, Chief Minister, U.P., was also present. Shri Kaka Saheb Kalelkar gave invaluable help to the Committee by his practical suggestions and advice during the several discussions which the Committee had with him.

The Committee would also like to record their appreciation of the co-operation and help extended by the various typewriter manufacturing concerns in the country, notably, Messrs Voltas Ltd., Bombay, Messrs Remington Rand of India Ltd., Calcutta, Messrs Godrej and Boyce Mfg. Co. Ltd., Bombay and Messrs. Royala Ltd., Madras. The representatives of these companies, especially Shri R.F. Lally of Messrs Voltas, Shri K.D. Manaktalla of Messrs Remington Rand, and Shri N.P. Godrej of Messrs Godrej & Boyce, gave valuable suggestions to the Committee regarding the mechanical aspects of the Hindi typewriter keyboard, and were keen to study and to accommodate as much as possible the various suggestions put forward by the Committee.

The Committee would further like to express its deep appreciation of the work which Shri Ajit Singh and Shri Kripa Nath Mishra of Patna have done in this field. The Committee had the privilege of receiving the fullest cooperation and help of both these gentlemen at various stages of its work, and have attached great weight to the numerous suggestions of actual or potential practical value made by them.

The Committee would also like to record their thanks to the large number of individuals who took pains to study the provisional typewriter keyboard published by the Committee in December, 1955 and who sent in their comments on the same. All these comments were carefully studied by the Committee and many of them were found to be very helpful.

The report is divided into two parts. Part I deals with the Hindi Type writer keyboard and Part II deals with the keyboard of the Hindi Teleprinter.

CHAPTER I

GENERAL CONSIDERATIONS

1.1 The Committee, in the very beginning, had to face the difficult task of incorporating the maximum number of characters on the keyboard so that the original character of the language remained unaltered and the maximum possible number of symbols and other signs etc., approved by the Lucknow Conference, could be incorporated in the Hindi typewriter keyboard. The Committee first undertook the task of deciding on the maximum number of keys that could be possibly put on a typewriter of standard and economical design. The limitation of the number of keys automatically puts a limit to the number of characters that could be incorporated on the typewriter keyboard.

1.2 The next task of the Committee was to choose a limited number of characters from the large number approved by the Lucknow Conference. The selection of characters was not easy. In addition to the very large number of full consonants and vowels in the Hindi language the Committee was faced with the problem of incorporating a number of half forms of consonants and a multitude of punctuation marks and other signs.

1.3 A preliminary survey of the problems was sufficient to convince the Committee that if speed and convenience were to be the main features of the typewriter keyboard, the characters must be arranged in such a way that the most frequent character would be operated by that finger which the typist can most conveniently manipulate. For this purpose it was necessary first to determine as to which particular keys on the keyboard could be considered as the easiest to operate, or in terms of typewriter phrasology, which of the keys would be the most propitious. The Committee undertook the task of preparing a large number of charts showing the relative propitiousness of keys in the entire keyboard.

1.4 While examining the English and other language typewriters, the Committee noticed that the arrangements of characters on the keys did not follow the scientific principle of locating the most frequent character on the most propitious key. To understand the basis of the English keyboard it studied all available literature on the subject. From this, the Committee found that the English keyboard has been made more or less on an *ad hoc* basis without going deeply into the scientific principles enunciated above. During the course of its work the Committee was gratified to read in the newspapers certain reports about typewriter keyboard reform in U.S.A., wherein it was proposed to modify the English keyboard on the principle of using the most propitious key for the most frequent character. The Committee realised that with the very large number of typewriters of the English language being used all over the world, a modification of the existing English typewriter keyboard would be a difficult task, notwithstanding the fact that the principles being proposed to be adopted were really the best scientific principles. For the Hindi typewriter, however, since we are standardising our first keyboard it would be in the fitness of things if these principles were followed.

1.5 Next, the Committee arranged the characters selected in their relative order of frequency of occurrence. The Committee got a few books of standard literature analysed to see the extent to which each character occurred in the language. Similar work had been undertaken earlier by the Hindustani Shorthand and Typewriter Committee set up by the Constituent Assembly

under the Chairmanship of Shri Kaka Saheb Kalelkar. On pages 133-134 of the Report of this Committee, a chart is given indicating the relative frequency of occurrence of the various characters in Devanagri script. The Committee found after examination that the frequency of occurrence of the characters which it was able to assess from an independent examination was more or less similar to the chart given in the Kalelkar Report. The Committee, therefore felt that the chart given in this Report would make a fairly reliable guide for the purpose in hand, and therefore this chart was adopted as a working basis by the Committee.

1.6 Once the relative propitiousness of the keys and the frequency of occurrence of the characters was determined, the Committee formulated the keyboard. But in doing so it has also kept in view a number of other practical and technical considerations, on account of which the strict frequency basis of the arrangement of characters has occasionally been modified. But such cases have been kept to the absolute minimum.

1.7 The Committee prepared the provisional lay-out of the keyboard sometimes towards the end of November, 1955 and the same was published in the press on the 5th December, 1955 inviting technical comments on the arrangements proposed. More than 300 comments were received each one of which was carefully considered by the Committee. Some of the suggestions were really helpful, and in the preparation of the finalised keyboard lay-out, due consideration has been given to them.

1.8 Certain comments were also received about the international form of Indian numerals which had been incorporated in the provisional keyboard. It was suggested in some of the comments that instead of the international form we should use Devanagri form of numerals. On further examination of the issue, considering the limitations of the number of keys on the typewriter keyboard, the Committee came to the conclusion that whereas it was an easy matter to have one form of numerals i.e. either the international form or the Devanagri form, in the standard typewriter keyboard, incorporating both forms would be a desirable though a difficult task. The Committee came to the further conclusion that it would not be proper to disturb the basic keyboard for incorporating the two sets of numerals and, perhaps, the only way it could be done was to make mechanical changes in the design of the typewriter machine which would permit typing of ten additional characters for the second set of numerals. The Committee accordingly discussed this aspect of the keyboard in great detail with the various typewriter manufacturing companies. The entire matter is explained in a subsequent chapter (VII). As would be seen therefrom no entirely satisfactory solution is available upto date and while recommending various different mechanical methods which could be adopted for this purpose, the Committee has left the door open to the manufacturers to adopt any suitable arrangement by which both forms of numerals can be incorporated on the topmost row of the Hindi typewriter keyboard. This has enabled the Committee to keep the basic keyboard design intact.

1.9 In the selection of the characters for the typewriter keyboard, the Committee was guided by the recommendations of the Lucknow Conference on Devanagri Script Reform. A few minor additions and modifications necessary to fill one or two inadvertent lacunae in these recommendations and to avoid any possibility of confusion or ambiguity, were suggested by the Committee and, after having been duly approved by the Government, they have been incorporated in the keyboard. These are: (a) the matra for ऋ () which had been inadvertently omitted from the final list of Devanagri characters recommended by the Lucknow Conference; (b) The 'ardhachandra' symbol () which had also been similarly omitted, (c) the straightening of the double inverted comma signs (" instead of "and") and replacing one of them by a single inverted

comma sign (`), so as to bring them in line with international usage and also to provide for both the single and double inverted comma signs without increasing the total number of characters; (d) putting a small loop at the end of the new matra for short ' ऋ ' ऌ ' instead of ' ऀ). This was to avoid confusion with the matra for long ' ठ ' likely to be caused by breaking of type, insufficient ink etc.

1.10. On various occasions the Committee came across suggestions that our keyboard design should be such that it could be adapted for the typewriters required for other Indian languages also. The Hindi and other Indian languages differ from the English language inasmuch as certain matras have to be typed above and below the characters for which the use of offset and dead keys is necessary. Further, the width of certain characters is considerably smaller than other characters and for these half movement keys are required. The Hindi typewriter keyboard, as standardised, has both these features which the Committee feels can be shared by all Indian language typewriters. But in the arrangement of keys and the location of offset and dead keys, the Hindi keyboard follows a specific pattern based on the relative frequency of occurrence of the various characters in the language. In other regional languages the frequency of occurrence would be obviously different and as such the basic pattern of the keyboard i.e. arrangement of keys and the location of offset and dead and half movement keys would have to suit the relative frequency of characters in the language.

The Committee felt that once the special features required for the Hindi keyboard are successfully designed and incorporated in the Hindi typewriters it will be an easy matter for the typewriting manufacturing companies to make the standard typewriter suitable for any other regional language based on the same principles. It would not be appropriate in the opinion of the Committee to fix the same position of half movement and offset keys for typewriters of all Indian languages. Such an arrangement is likely to result in keyboard arrangement which may not be satisfactory for all the languages and may not permit the observance of the principle of relative frequency of occurrence of characters while designing the keyboards of various languages.

1.11 There were suggestions that we should have bilingual typewriters so that the same typewriter can be used for Hindi and one other regional language or English and Hindi etc. This, the Committee, after mature consideration, did not consider either practical or even desirable. Any such arrangement would result in a costlier and more cumbersome machine without giving much practical utility. The Committee, therefore, proceeded to design a keyboard incorporating basic features which should be suitable for the keyboards of all Indian languages. The arrangement of the Hindi characters of keyboard has been done primarily for Hindi. With minor re-arrangement of keys, we can adapt this keyboard, for any other Indian language. This re-arrangement would be of the same type as can be seen in the various typewriters manufactured by any one Company, for various European and other languages using the Roman script where the basic typewriter design is identical but the arrangement of keys differs from language to language.

CHAPTER II

CHARACTERS SELECTED FOR THE KEYBOARD

2.1 The first question examined by the Committee was in respect of the number of characters which could be accommodated on the Hindi typewriter keyboard. Almost all standard typewriters in English, Hindi and other languages were found to have a maximum number of 46 keys. The number of keys available on portable typewriters is normally 42, though in some recent models we have also come across 43 and 44 keys. The Committee held discussions with representatives of typewriter manufacturing companies and a number of experienced stenographers and typists and came to the conclusion that though theoretically, it is possible to have more than 46 keys on a typewriter keyboard, yet from the point of view both of convenience of operation and of economy in manufacture (since this is the standard size of typewriters in use all over the world) it would be necessary to restrict the maximum number of keys for the Hindi typewriter to 46. It was also felt that out of these 46 keys 42 should form the basic keyboard and the remaining 4 keys should be reserved for those signs and symbols which, if necessary, could be omitted in a portable typewriter. This arrangement would ensure that both in case of a standard typewriter and a portable typewriter the basic keyboard would remain the same.

2.2 Once the size of the keyboard was decided upon, it became necessary to examine as to which particular characters should be incorporated in the keyboard. In this respect, the Committee was guided by the recommendations of the Lucknow Conference in Devanagari Script Reform held in November, 1953, which have since been accepted by the Government of India. This Conference has standardised the forms of 123 characters, including vowels, matras, consonants, numerals, conjuncts, punctuation marks and other symbols. A list of these characters is given in Appendix 'A.'

2.3 Obviously, all of these 121 characters cannot possibly be incorporated in any typewriter keyboard owing to the limitation of 46 keys, which permits the inclusion of a maximum of 92 characters. A detailed examination of these characters was, therefore, made in order to decide which of these could be eliminated without in any way modifying the basic recommendations of the Lucknow Conference and adversely affecting a faithful reproduction of the Hindi language. In determining this, the most important consideration, apart from others, was the frequency of occurrence of various characters in the language. On page 133 and 134 of the Kalelkar Report a Frequency Chart is given indicating the percentage occurrence of each character, i.e., the number of times each character appears amongst every 100 characters in normal Hindi writing. This Chart has been reproduced in Appendix 'B.' This Frequency Chart has been of very valuable assistance to the Committee. The Committee also prepared a Frequency Chart of their own independently, but since it was almost similar to the Frequency Chart given in the Kalelkar Report, the Committee instead of adopting a new chart worked on the basis of the latter.

2.4 Taking the vowels first, the Lucknow Conference has recommended the adoption of 15 vowels as given below:—

अ, आ, इ, ई, उ, ऊ, ऋ, ए, ऐ, ओ, औ, अं, अः

All these characters can be formed by five basic characters, viz. अ, इ, उ, ऋ and ए by combining them with suitable matras and symbols. The vowel 'लृ' can be formed by combining the consonant 'ल' with the matra for 'ऋ'

i.e. ' '). The Committee, therefore, decided to include only these five basic vowels characters in the proposed typewriter keyboard.

2.5 The Lucknow Conference also recommended the adoption of the following 12 matras and signs:—

- ८ (for long a)
- ८ (for short i)
- ८ (for long i)
- ८ (for short u)
- ८ (for long u)
- ८ (for ए)
- ८ (for ऐ)
- ८ (for ओ)
- ८ (for औ)
- ८ (for anusvara)
- ८ (for anunasika)
- ८ (for visarga)

The matras '८' and '८' can be formed by combining the matra '८' with '८' and '८' respectively. The chandrabindu (८) can be formed by combining the sign of anusvara (८) with the ardhachandra (८). This ardhachandra has not been given as a separate sign by the Lucknow Conference. But the Committee has thought it necessary to include the ardhachandra because it will enable faithful reproduction of such sounds as the board monophthongs in words like 'पैसा' and 'और' and the short 'ए' and 'ओ' sounds, which occur in languages like English, Telugu etc. where words have either gained currency in Hindi or may have to be transliterated into Devanagari. No separate symbols exist in Devanagari at present for these sounds. The inclusion of the ardhachandra symbol will thus increase the richness of the keyboard without taking up additional keys. It may also be mentioned here that while the vowel 'ऋ' has been included in the Lucknow Conference recommendations, the matra for this vowel appears to have been inadvertently omitted. This matra had also, therefore, to be included among the matras in the proposed keyboard. In all, therefore, the Committee has adopted the following 11 matras and signs:—

८, ८, ८, ८, ८, ८, ८, ८, ८, ८, ८ :

2.6 The shape of the short '८' matra, as recommended by the Lucknow

Conference, is slightly different from that given above in as much as the former does not have the loop and its vertical stroke stops half way down. By actual experiments in writing this matra, the Committee has come to the conclusion that it is virtually impossible to stop the vertical stroke half way in actual rapid running writing. The short loop at the end of the half vertical stroke, on the other hand, greatly facilitates the writing of this matra and also helps in distinguishing it clearly from the long '८' matra. The printing experts have also given their opinion that the type of this matra without a loop is likely to break. The Committee, therefore, has adopted the slightly modified form with a loop at the end. The slight modification has been approved by the Government of India.

2.7 Among the full consonants, the Lucknow Conference recommended 36 characters including '८' which has been accepted to make the typewriter suitable for Vedic Sanskrit and Marathi, but excluding '८' which the Conference considered unnecessary. The proposed keyboard will permit the typing of all these 36 consonants.

2.8 The Lucknow Conference had further recommended the adoption of two methods for forming conjuncts—one by the use of *halant* in all cases and

the other by the use of half letters which are normally formed by dropping the vertical stroke, called the 'Khari Pai'. In case of 12 consonants, namely, क, ड, छ, ठ, ङ, ट, ढ, द, फ, र, ह, ङ which do not have a 'Khari Pai,' the Conference recommended adoption of special half forms for 3 consonants only, namely, क, फ, and ह, and the use of *halant* for the rest except 'र' for which separate symbols have been provided where it occurs in conjunct formations. Thus, the Lucknow Conference has provided for half forms of 25 consonants out of 36.

2.9 With the maximum number of characters in the typewriter limited to 92, it is obviously not possible to incorporate the full and half forms of all these 27 consonants. The Committee, however, felt that in order that the script of the typewriter should approximate as closely as possible to the actual written script, it was essential that the maximum possible number of half forms of consonants be included in the typewriter keyboard. The formation of conjuncts by the use of *halant* has, therefore, been restricted to the minimum.

2.10 In providing for the half forms of consonants in the Hindi typewriter keyboard, the Committee has been generally guided by the recommendations of the Lucknow Conference and also by the relative frequency of occurrence of the half forms of letters. Taking both these factors into consideration, the Committee has provided half forms for 17 consonants but has not provided half forms of the following 10 consonants for the reasons given against each —

- (i) झ, फ, ह, ज, The half forms of these consonants are practically non-existent in Hindi. These do not, therefore, find mention in the Frequency Chart prepared by the Kalelkar Committee. It is true that half forms of some of these letters occur in Sanskrit and in Marathi with a greater frequency than in Hindi. But even in these two languages, the frequency of those half forms is still very low and the need of these languages can, therefore, be met adequately by the use of the *halant*.
- (ii) ग, घ, थ, भ, and य:— The relative frequency of the half forms of these letters is negligible, ('ग': .0325%, 'घ': .0655%, 'थ': .0055%, 'भ': .027 and 'य': .012%) The absence of these half forms would, therefore, not in any way materially affect the faithful reproduction of the Hindi language.
- (iii) 'ख':— In addition to the very low frequency of the half form of this consonant (1.0975%) the modified shape of this consonant, as recommended by the Lucknow Conference, does not permit easy writing of its half form. This has been tested by the Committee by actual experiments. The half form of this consonant has, therefore, not been provided.

2.11 Detailed examination of the frequency of occurrence of letters also showed that the frequency of half forms of certain consonants was relatively high when compared to the frequency of their full forms. These consonants are 'ण', 'ध', 'श', 'ष', 'ज्ञ'. Further, the total frequency of the full and the half forms of these consonants is comparatively small viz.—

ण : . 51%
ध : . 62%

श : .74%
 ष : .27%
 क्ष : .13%

It was felt that in such cases our purpose would be served if these characters were put on the typewriter keyboard only in their half forms. Their full form could then be made by combining their half form with the matra for long 'आ' (which has been designed to serve as a 'Khari Pai' also). The Committee, therefore, provided the half form only of these five consonants.

2.12 The consonant 'झ' never occurs in its full form even in Sanskrit. Only half form of this consonant has, therefore, been provided.

2.13 For the sake of economy of characters, the consonant 'फ' has not been provided separately because it can be formed by combining 'प' with a special symbol ;, which has been separately provided (see para 2.19 below). The frequency of occurrence of the full consonant 'फ' is also very low in Hindi (viz., .036%). The half form of this consonant occurs hardly at all, as already mentioned above (2.10).

2.14 The consonant 'ड' never occurs in its full form in Hindi. So the Committee has not separately provided for this consonant which can be formed by adding the decimal dot to the letter 'ड'. The frequency of occurrence of this letter is very very small being, .012%. Therefore, making it by a double stroke will not effect speed.

2.15 The Committee has thus provided for 11 consonants both in their full and half forms, 6 consonants in their half forms only, and 17 consonants in their full forms, making a total of 34 characters. These are given in Appendix C.

2.16 *The Common words of address 'श्री' :*

The common word of address 'श्री' (equivalent to Mr. in English) is now used very frequently in the language both in official and non-official correspondence. We have provided the half form of 'श' only in the keyboard and forming 'श्री' from this would require four strokes. In the interest of speed, therefore, the Committee has provided for the full word 'श्री' on one of the home row keys, since this is a word which the Hindi typist will now be called upon to type with ever increasing frequency.

2.17 *Punctuation marks*

The Lucknow Conference has recommended the following punctuation marks:—

— — ; ! ? । and ,

Of these the Committee decided not to include the semi-colon as a separate sign. This can be formed by combining the comma with the dot of the decimal sign (see para 2.19 below). The Committee also decided not to have the sign of exclamation (!) as the same could be formed by using the 'viram' sign and the bottom dot (.) (see para 2.18 below). Based on these considerations the Committee has provided for 5 punctuation marks in the keyboard, viz., 1. the hyphen (-) : 2. the underlining dash (—) 3. the comma (,) : 4. the sign of interrogation (?) and, 5. the viram sign (।).

2.18 *Other symbols:*

The Lucknow Conference suggested the following 16 additional symbols for inclusion, as far as possible, in the keyboard of the Hindi typewriter —

= . % " ' () + × ÷ * † / ^ ^

Of these, the Committee has provided for all except the † sign.

The shape of the inverted commas has been slightly modified. The straight form of the double inverted commas has been adopted so that the same symbol can serve both for the opening and the closing inverted commas, as is the case in all the English and European language typewriters. In lieu of the second double inverted commas, the Committee has included the single quote sign thus adding to the richness of the keyboard without adding to the total number of characters.

Two of the above symbols will be formed by combination as indicated below:—

- (i) The plus sign (+) will be formed by combining the Viram sign with the hyphen (-).
- (ii) The Division sign (÷) will be formed by combining hyphen with the visarga.

The dot (.) included in the symbols above will appear below the line of letters. It will be used for the following purposes:—

- (i) To form 'ड' and 'ढ' from 'ड' and 'ढ' respectively.
- (ii) To express certain Perso-Arabic sounds like क़, ख़, ज़, क़, etc.
- (iii) As a full stop (.)
- (iv) To form the sign of exclamation from the 'viram' sign.

2.19 In addition to the symbols mentioned above, the Committee, in order to economise in the number of characters which have to appear in the typewriter keyboard, have adopted two special signs or symbols. These are given below —

- (a) The sign 'ऀ'. It will be used both for making long 'ऊ' from short 'उ', 'क' from 'क' and 'र' from 'र' respectively.
- (b) A second dot sign (.) has been provided to appear in the centre of the line of typing. This would be used:—
 - (i) for the formation of 'ड' from 'ड'
 - (ii) for the formation of the semi-colon from comma and
 - (iii) as a decimal sign.

Based on all these considerations, the Committee has adopted the following 15 symbols —

ˆ ˆ ˆ / ˆ ˆ % ˆ ˆ () × * = ˆ

2.20 It will thus be seen that the total number of vowels, consonants, matras, punctuation marks and other symbols to be included in the Hindi typewriter comes to 82, with the following detailed breakup:—

Vowels.....	5
Matras and signs.....	11
Consonants	45
The address word ॐ	1
Punctuation marks	5
Other symbols.....	15

2.21 The maximum number of characters which it is possible to include in a Hindi typewriter keyboard being 92, ten more spaces on the proposed keyboard are, therefore, left. These have been allotted to the ten numerals.

There has been considerable controversy regarding the form of numerals to be used in Hindi for the official purposes of the Union and the States. Two alternative forms i.e. the Devanagari form and the International form of Indian numerals have been advocated. The use of the International form has been

prescribed by the Constitution for the official purposes of the Union [Article 343 (i)]. But in the subsequent articles relating to the States the form of numerals has not been specifically prescribed.

The Committee explored all possible ways for incorporating both forms of numerals in the same keyboard without increasing the total number of its keys. It found that there were several methods of which this could be done. These have been discussed in detail in Chapter VII.

2.22 Characters finally included in the keyboard

A list of the characters which have thus been finally adopted for the Hindi typewriter keyboard is given in Appendix 'D'. The reasons for their adoption have been discussed in detail above. In the selection of the characters the recommendations of the Lucknow Conference have been kept in view and faithfully followed. The very minor modifications in the shape of the matra for short 'इ' and of the inverted commas, and the inclusion of the matra for 'ऋ' (ॠ) and ardhachandra (ॡ) and the single quote sign (') which were presumably left out inadvertently, from the recommendations of the Lucknow Conference have been approved by the Government. These minor modifications and additions were found to be essential for the evolution of an efficient and complete keyboard for the Hindi typewriter.



CHAPTER III

ARRANGEMENT OF KEYS AND THEIR RELATIVE PROPITIOUSNESS

3.1 Having selected 92 characters which were to be incorporated in the standard Hindi typewriter keyboard, the Committee next went on to consider the arrangement of keys in this keyboard and their relative propitiousness, i.e. the comparative ease in operation, of these keys.

3.2 *Arrangement of keys:* For this purpose, an examination was made of the keyboards of all existing makes of typewriters of Hindi, English and other languages like French, Russian and Spanish. It was found that the arrangement of keys in all these typewriters generally followed the following pattern—

- (a) The keys were arranged in four rows, one above the other.
- (b) The second row from the bottom was taken as the home row on which the typist's fingers would normally rest.
- (c) Thirty nine keys, i.e. 9 in the bottom or the first row and 10 each in the remaining rows, form the basic keyboard which is operated by the touch method. Of these 39 keys, the right hand fingers operate five keys in each of the four rows and the left hand finger operate four keys in the bottom row and five keys each in the remaining three rows. The arrangement of the remaining seven keys is different in different makes of typewriters. But they are always added on the right hand side of the basic keyboard and are distributed in all the four rows.
- (d) In portable typewriters, which have from 42 to 44 keys, the additional 3 to 5 keys are also added on the right hand side of the basic keyboard, which is the same as in a standard typewriter.

3.3 On the basis of this detailed examination, it was decided to have for the Hindi typewriter the same arrangement of keys, i.e., having four rows, one above the other, and having 39 keys in the basic keyboard in order of 9, 10, 10 and 10. Three additional keys, which can also be operated by the touch method have been provided one each in the bottom second and third rows on the right hand side of the basic keyboard. Four more keys, normally operated by sight, have then been added, one to the third row at the right, one to the top row at the extreme left and the remaining two to the top row at the extreme right. This arrangement makes for what may be called the inverted pyramid design of the keyboard in which the bottom row has the least number of keys and the other rows onwards have a progressively increasing number of keys. In this case the number of keys will be as follows:—

Bottom row	10 keys
Home row	11 keys
Third row	12 keys
Top row	13 keys

The Committee feels that this arrangement of keys is the best because it follows the natural movement of the fingers of the two hands which spread out when they go up, but come closer together when they move down. Nevertheless, the exact location of the last four keys, which will be operated by sight,

is optional and can be left to the choice of the various manufacturers. The conventional arrangement so far has been to have 11 keys in the bottom and top rows and 12 keys each in the second and third rows.

3.4 The portable typewriters would have the 42 keys operated by the touch method and if possible two additional keys operated by sight. Six charts of the arrangement of keys in the standard and portable typewriter keyboards are given in the appendix 'E, I-VI'.

3.5 In the touch method, the fingers of both the hands rest on the home row so that the fourth or little finger of the left hand rests on the first key from the left and the little finger of the right hand rests on the tenth key from the left. The second, third and fourth fingers of each hand would operate one key each in the home row as well as in the third and fourth rows. The first finger of each hand would operate two keys on each of these three rows. For the bottom row, the arrangement would be slightly different. The first and the second keys from the left would be operated by the third and second fingers respectively of the left hand. The third and fourth keys from the left will be operated by the first finger of the left hand. On the right hand side, the five keys will be operated in the same manner as for the other rows, i.e., one key each of the second, third and fourth fingers and two keys by the first finger. This arrangement is illustrated by a sketch given in appendix 'F.'

3.6 The three additional keys added to the bottom, second and third rows for operation by the touch method will be operated by the little finger of the right hand. The last four keys, three of which are added to the right hand side of the keyboard, and are to the left will be operated by sight by the little finger of the right and the left hand.

3.7 Normally the top row in the keyboards of English typewriters is not operated by the touch method. It was found that it is not really very necessary to adopt the touch method for characters on this row because on the English keyboard this row has only numerals and certain other miscellaneous signs, the frequency of occurrence of which is very small and no impairment to speed occurs if keys on the top row are operated by the sight method. In the Hindi typewriter, we have per force to accommodate certain essential characters of the language in the top row in addition to the numerals. It will, therefore, be necessary to type this row also by the touch method. However, the characters included are the last frequent, and even if a particular typist feels it more convenient to operate the top row by the sight method, it will not impair his speed.

3.8 *Relative propitiousness of keys*

The speed in typewriting will depend on the ease with which a particular character can be typed. This depends on the position of the key carrying that character. As has been said above the different keys on the keyboard are typed by different fingers of either hand. The fingers not only have to move up and down on the keyboard from the home row, but the agility and the strength of each finger is also different. Therefore, the ease with which a particular key can be typed will necessarily vary depending on its position and the finger with which it is operated. It follows, therefore, that, fundamentally speaking, it is essential in the interest of speed that characters which are most frequent in the language should be allotted keys which are most convenient to operate. To find out how far this fundamental principle was being adopted in the standard English and other languages' typewriters, a detailed study of the frequency of occurrence of the characters and relative ease in typing particular keys, i.e., their relative propitiousness, was made. The Committee was surprised to find that this principle of arrangement of characters on the basis of relative propitiousness of the keys was not followed in any of the keyboards examined, and, generally, the arrangement was more or less arbitrary. No definite explanation

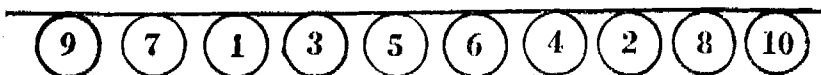
for this could be obtained by the Committee. But it came to know by having a discussion with various manufacturers and by looking into reference books on the subject that the arrangement of letters on the keyboard of the English typewriters was made by a convention amongst the manufacturers, and the Committee presumes that this is the case with typewriters of other languages also. So far as the existing Hindi typewriters are concerned, each manufacturer has developed his own keyboard which differs materially from others. This the Committee felt was a most unsatisfactory position. In the interest of speed and facility of operation the Committee came to the conclusion that the adoption of the double principle of frequency of occurrence of a character and the relative propitiousness of the various keys on the keyboard was most essential. The Committee was gratified to note from reports which recently appeared in the daily Press that even in England and America the need was being increasingly felt to reform the existing English typewriter keyboard and to base it on scientific principles which in essence are the same as those independently formulated by the Committee and enunciated above.

3.9 No data could be procured by the Committee regarding the principles by which it could be guided in determining the relative propitiousness of the various keys. The Committee, therefore, conducted their own trials with the help of a number of efficient stenographers and typists and was also guided partly by material made available by Shri Kaka Sahib Kalelkar, which was collected by him on the basis of actual experiments. The results of these tests conducted and the inference from the material available from Shri Kaka Sahib Kalelkar showed that the following basic considerations should determine the relative propitiousness of the keys:—

- (i) The home row on which the fingers normally rest, i.e., the second row from the bottom, is the most convenient to type. The row above the home row, i.e., the third row from the bottom is the more convenient to type than the bottom row. The top row is the least convenient to type.
- (ii) In the home row the operation of keys under the left hand is slightly more convenient than the operation of those under the right hand.
- (iii) The middle finger is the strongest and the easiest to operate in the home row.
- (iv) The first finger which types two characters in each row is the most agile and manoeuvrable, and though in the home row the middle finger is more quick, in other rows the first finger is more convenient to use than the middle finger.
- (v) Next in order, in respect of agility and manoeuvrability are the third and fourth fingers of each hand. Due to the greater agility of the first and second fingers, the operation of keys even in the bottom row by these fingers is more quick than operation of keys by third and fourth fingers in the third row.
- (vi) Except in the home row the operation of the third and fourth fingers is more convenient by the right hand than by the left.

There are a few exceptions to these basic considerations which will be discussed further on.

3.10 The relative propitiousness of the ten keys in the home row on the above considerations is as shown in the sketch below—



3.11 In the third row the most propitious key is the fourth from the left which will be operated by the first finger of the left hand. The next in order is the seventh key from the left being similarly operated by the first finger of the right hand. The third and the eighth keys are operated by the middle finger and the fifth and the sixth keys by the first fingers of either hand. The position of the fifth and the sixth keys is such that the first finger has to travel a greater distance to operate the fifth or the sixth key. The third and the eighth keys, being operated by the middle fingers of either hand, are thus more propitious than the fifth and the sixth keys operated by the first fingers of either hand.

The other keys in the third row are operated by the third and fourth fingers, and their relative propitiousness is less than the keys in the bottom row operated by the first and second fingers as indicated in the basic considerations above. Their propitiousness would be discussed later.

3.12 In the bottom row the most propitious key is the fourth key from the left which is operated by the first finger of the left hand. The fourth key is so positioned that for operating it the first finger of the left hand has to make a downward movement to the right which is easier than that of the corresponding downward movement to the left. Next in order is the sixth key from the left operated by the first finger of the right hand. The third key from the left which is also operated by the first finger of the left hand comes next in propitiousness. The fifth key from the left which is operated by the first finger of the right hand is not so convenient to operate because the finger has to move a considerable distance. Easier than this key is the typing of the seventh key from the left which is operated by the middle finger of the right hand followed by the second key from the left which is typed by the middle finger of the left hand. There is an apparent exception in our general principles mentioned above that the first and the second fingers of the right hand are less propitious than the corresponding fingers of the left hand. The reason is that for operating the seventh key, the middle finger of the right hand has to move towards the left. While in, operation of the second key, similarly, the middle finger of the left hand has to move towards the left. Movement of the right hand towards the left is easier than movement of the left hand towards the left.

Next in propitiousness follows the fifth key from the left which is operated by the first finger of the right hand.

3.13 The remaining keys in the bottom and the third rows are operated by the third and fourth fingers. As it is more convenient to move the fingers up than down according to the general principle enunciated above, the ninth key in the third row which is operated by the third finger of the right hand comes next in order of propitiousness followed by the second key from the left in the same row typed by the third finger of the left hand. Next in order come the eighth and the first keys from the left of the bottom row operated by the third fingers of the right hand and the left hand respectively.

3.14 The little finger of the right hand types the ninth key in the bottom row and the tenth key in the third row. Here we find another exception to the general rule enunciated above in as much as the ninth key from the left in the bottom row is found to be more propitious than the tenth key from the left in the third row. This is because it is more convenient for the little finger of the right hand to move downward to the left than to move upward to the left. Next in propitiousness is the first key of the third row operated by the little finger of the left hand. This completes the relative propitiousness of the keys in the first three rows from the bottom.

3.15 The three extra keys added one each to the home row, third row and the bottom row operated by the little finger of the right hand follow next in propitiousness in the same order.

3.16 The relative propitiousness in the top row follows the basic general rules enunciated above, that is, the keys operated by the first finger of either hand are the most propitious followed by those operated by the middle finger, the third finger and the little finger respectively and the keys operated by the first two fingers are more propitious in the case of the left hand and the keys operated by the third and the fourth fingers are relatively more propitious in the case of the right hand.

3.17 The four additional keys which are added in standard machines and which will be operated by sight by the little finger of the left and the right hand may be taken to be the last four in order of relative propitiousness. Amongst these the first key to the right in the top row would be the most propitious followed by the key to the right in the third row. The key in the top row is more propitious here than the key in the third row because the little finger of the right hand will move more naturally up towards the top row than onwards to the last key in the third row. Next in order of propitiousness is the extreme right key in the top row operated by the little finger of the right hand. The last and the least propitious key will be extreme left key in the top row which will be operated by the little finger of the left hand. A chart showing the relative propitiousness of all the 46 keys is given at Appendix 'G.'



CHAPTER IV

MOVEMENT OF KEYS

4.1 In an English typewriter every time a key is pressed, the paper moves by a distance equal to the space allotted to a character. But the Devanagiri script does not follow the pattern of Roman characters. There are several matras and symbols in Devanagiri which have to be typed above or below the main characters. To enable us to type these matras and symbols, as required, it is necessary to have such an arrangement that when the matras are typed the carriage does not move. For this purpose, special keys known as 'dead' keys are required.

4.2 Further, in English typewriters and in typewriters of most other languages the movement of the carriage is uniform for all characters, i.e. the carriage moves the same distance when any key is pressed. This is a defect even in these typewriters since it does not permit natural space adjustment of various letters of varying widths. In Devanagiri, and most other Indian languages, this mechanical uniformity of movement is very undesirable for here we have half-characters and matras both short and long, which occupy much less space than a full character and therefore it becomes necessary to have an arrangement by which the carriage would move only a portion of the normal distance whenever these matras and half characters are typed.

4.3 Two special mechanical features have, therefore, to be incorporated in the Devanagiri typewriter. These are:

- (a) Dead keys (i.e. keys which will not cause the carriage to move when pressed);
- (b) Half movement keys i.e. keys which will cause only a part movement of the carriage when pressed.

There are no special mechanical difficulties in incorporating both these special features in Devanagiri typewriters. In fact most of the Hindi typewriters already have dead keys and a few have half-movement keys as well. This matter was discussed by the Committee at length with the various typewriter manufacturers and the Committee was assured that incorporation of these two special features which will permit the typing of Devanagiri in a natural manner as it is written, will not result in any mechanical difficulties. Both these features could easily be incorporated in any standard typewriter.

4.4 The provision of half-movement in certain keys will necessitate the provision of a half back spacer, because whenever, after typing a half movement character, the carriage is to be moved back for some correction, it has to be moved back only by half a space. The typewriter could incorporate a full back spacer also but since the back spacing feature is made use of only rarely, it was not considered necessary by the Committee to recommend the provision of a separate full back-spacer also. For moving back the carriage one full space, the back spacer will merely have to be pressed twice. This is not likely to cause any special inconvenience.

4.5 Discussions with typewriter manufacturing experts also brought out the following facts —

- (i) Any number of keys could be made half-movement keys without much difficulty;
- (ii) any key in the key-board, irrespective of its position, could be made a half-movement key;

- (iii) The half movement could be provided in any key in either of both the shifts, i.e., a particular key could have a half-movement character in the lower shift and full movement character on the upper shift and vice versa, and further a key could have a half-movement character on both shifts.

This permits the positioning of half-movement keys in any desired part of the keyboard.

4.6 Normally, in all existing English and Devanagiri typewriters the arrangement of typing and carriage movement is such that the carriage moves after the character has been typed and the space for the type of the next character moves into place. This creates a special difficulty in Devanagiri script when matras have to be typed above or below a character which has already been typed and has moved to the left. Typing of matras above and below such characters obviously requires offsetting of the types, i.e., the character on the type face is so positioned that it is off-set towards the left. This necessitates the use of broader or 'L' shaped type faces. But the type faces are so positioned in the basket that there is very little space between one type face and the other, particularly in the central part of the basket. For this reason most of the manufacturing concerns have put the off-set keys towards the end—mostly on the right. This places a severe limitation on the layout of a scientific keyboard based upon the frequency of occurrence of characters in the language. However, provision of off-set keys in the centre is not impossible and the Committee found that certain manufacturers had actually incorporated this device near the centre of the basket by grooving the adjacent types. In further discussions with the manufacturers all of them agreed that this could be done though it is mechanically more convenient to have such keys on either side of the keyboard. The Committee, therefore, has not let this consideration interfere with the other basic considerations for a scientific layout of the keyboard, though it has avoided placing offset keys right in the centre of the keyboard when this could be done without prejudice to other considerations.

4.7 The Committee has also considered the feasibility of completely omitting off-set keys. This is possible if the movement of the carriage takes place not after the typing of the character, but before the character is typed. This will enable the previous character to remain in place till the next character is typed and if matras have to be placed above or below that character this could be easily done by operation of the dead keys which will not make the carriage move. This would then obviate the necessity of having off-set keys. The typewriter manufacturers in discussions held with them were given the option of either providing the off-set keys in the manner suggested above, or adopting this procedure which will do away with off-set keys. They, however, pointed out that there were mechanical difficulties in adopting this device.

CHAPTER V

POSITIONING OF CHARACTERS ON THE KEYBOARD

5.1 The Committee has provided 46 keys for the standard typewriter, which is the maximum that a standard typewriter can take and a typist can conveniently handle. The portable typewriter will, however, have a maximum of 44 keys. Some of them may have only 42 or 43 keys. It is necessary to ensure that the keyboard of the portable as well as of the standard typewriters is essentially the same so that it does not cause any inconvenience to a typist when he changes from one to the other. The Committee felt that there should be a basic keyboard of 42 keys which will be the same for all typewriters—whether standard or portable (as is the case with all existing English and most European typewriters). Characters which are put on the remaining four keys should be such that their inclusion in the keyboard would enrich it, but the absence of one or more of them would not seriously affect the utility of the typewriter. For this purpose the Committee decided that in a portable typewriter with 44 keys the following four symbols out of the 92 characters finally selected (see Appendix D) could be excluded:—

1. The asterisk mark (*)
2. The percentage mark (%)
3. The equation symbol (=)
4. The multiplication symbol (×)

These marks and symbols have the least frequency in normal typing and therefore are not indispensable for the purpose for which a portable typewriter is commonly used.

5.2 The Committee further felt that in a portable typewriter having only 43 keys, the following two punctuation marks, in addition to the four marks and symbols mentioned above, may also be omitted for the same reasons:—

1. The single quote sign..... (')
2. The sign of interrogation..... (?)

5.3 In a 42 keys portable typewriter two further signs would have to be omitted. And working upon the same principle of relative frequency and need in actual typing of the signs and symbols, the two bracket signs come next in the order of least frequency and need. These would therefore be omitted from a 42 keys typewriter.

5.4 The remaining 42 keys will form the basic keyboard of all typewriters, standard or portable, and will be completely identical in all cases.

5.5 Out of these 42 keys three keys will be reserved for the following six punctuation marks and other symbols used for punctuation :—

1. The comma (,)
2. The oblique (/)
3. The viram (!)
4. The colon (:)
5. The hyphen (-)
6. The double quote marks (")

The 8th, 9th and 10th keys on the right side of the bottom row have been allotted to these signs in the order given above. This arrangement

has been adopted for the sake of convenience and follows more or less the pattern of English typewriters with which our typists are already familiar.

5.6 The following twelve matras and other symbols have to be put on dead keys because they do not require the movement of the Carriage :—

- | | |
|--|-------|
| 1. The matra for short उ | (ॐ) |
| 2. The matra for long ऊ | (ॐ) |
| 3. The matra for ऋ | (ॐ) |
| 4. The matra for ए | (ॐ) |
| 5. The matra for ऐ | (ॐ) |
| 6. The sign for half र when first member of a conjunct | (ॐ) |
| 7. The sign for half र when last member of a conjunct | (ॐ) |
| 8. The sign for making 'ऊ' & 'क' | (ॐ) |
| 9. The ardhachandra | (ॐ) |
| 10. The anusvara | (ॐ) |
| 11. The halant sign | (ॐ) |
| 12. The dot below letters | (ॐ) |

Six keys have been made dead into the keyboard, in order to accommodate these 12 characters.

5.7 This leaves a balance of 33 keys on which the other characters of the script are to be provided. These characters are:—

(a) Full vowels	...	...	5
(b) Full consonants	...	...	29
(c) Half characters (which appear in their full forms also)	...	...	11
(d) Half characters for which no full forms are provided separately	...	...	6
(e) Numerals	...	...	10
(f) Matras for long 'आ', short 'इ' and long 'ई' (for which half movement keys are provided)	...	...	3
(g) The underlining—	...	...	1
(h) The multipurpose dot	...	...	1
Total No. of characters			66

5.8 In case of the 11 consonants which have been provided with both full and half forms, the Committee felt that for convenience of typing the half forms of such letters should be placed on the same key on which the full forms are put. Here again the analogy of the English typewriter has been followed where the smaller and the capital forms of each letter are given on the same key. Working on this basis, it was decided to reserve 11 keys for those consonants which appear in both full and half forms—the full forms being placed on the lower shift and the half forms on the upper shift.

5.9 The numerals occupy the top row on most of the existing typewriters. This is because the frequency of their occurrence is comparatively low, and the top row, being the least propitious of the four rows, has been utilized for this purpose. For the same reason the Committee has also allotted the numerals to the top row.

5.10 In European typewriters, the numerals are provided in the lower shift of the top row and, in addition, certain punctuation marks and signs are provided on the upper shift of the top row. In Hindi the number of main characters is so large that the top row has also to be used for some of the characters. The frequency of occurrence of numerals being comparatively lower than these main characters, the numerals have been placed in the upper shift of the top row.

5.11 In the allotment of characters to the various keys the Committee was mainly guided by the principle of frequency of occurrence of the character in the language and the relative propitiousness of the various keys. The most frequent character has normally been allotted to the most propitious key. In determining the frequency of a character for this purpose, the Committee has taken into consideration the various contexts in which a particular character is likely to be used. Thus, if a half character is used to form the full character also, the frequencies of the half and the full characters have been added to determine the total frequency of this character.

Similarly, if a character is utilized to make other characters from it, the frequency of that character by itself and the frequencies of all the other characters formed from it are added up to determine the total frequency of that character. The Committee has prepared, on this basis, a complete chart of the total frequencies of all the characters selected for this keyboard. This chart has been reproduced in appendix 'H'.

5.12 The principle of allotment of keys on the basis of frequency of occurrence has however, not been adhered to in a mechanical manner. Certain practical and technical considerations have also been kept in mind. This has resulted in a keyboard which is both scientific and convenient to handle.

5.13 Some further general considerations which have guided the Committee in the allotment of various characters to the different keys are discussed below:—

- (a) Matras in Hindi have the same value and therefore the same importance as full characters. All of them therefore except the matra for 'ऋ', whose frequency is comparatively very low, have been put in the lower shift which will make it possible to type them without change of shift. This will mean very considerable increase in typing speed and ease of operation. These matras have been allotted keys mainly on the basis of their frequency of occurrence and no attempt has been made to segregate them or to group them, as has so far been the usual practice in the existing Hindi typewriters.
- (b) The matras for corresponding vowels are so arranged that while the short matra is operated by the left hand the long is operated by the right. This will help the memory of the typist.
- (c) Characters like 'न', 'म' which are frequently juxtaposed in single words have been placed on different sides on the keyboard so that they can be operated by the left and right hand respectively. This will make typing of such words as 'नमस्कार', 'दमन' etc. very convenient.
- (d) Different full characters put in the lower and upper shift of the same key have been so chosen that normally they are not juxtaposed in the same word e. g. 'य' and 'झ'; 'ए' and 'ठ'; 'उ' and 'ट'; 'ह' and 'ख'; 'इ' and 'ढ'; 'द' and 'ड' etc. This again will result in considerable ease and convenience in typing.

5.14 Keeping in mind the total frequency of occurrence of characters as indicated in appendix 'H' it would be seen that the most frequent characters are:—

1. The matra for long	‘आ’	:	Frequency	11.62 %
2. The matra for	‘ए’	:	”	8.93 %
3. The consonant	‘क’	:	”	7.03 %
4. The consonant	‘र’	:	”	4.29 %
5. The matra for short	‘इ’	:	”	4.04 %
6. The consonant	‘ह’	:	”	3.92 %
7. The consonant	‘स’	:	”	3.90 %
8. The matra for long	‘ई’	:	”	3.60 %
9. The consonant	‘त’	:	”	3.52 %

These have, therefore, been allotted the most propitious keys *i. e.* the lower shift in the home row. The relative propitiousness of the keys in the home row is given in Appendix 'G'. The numbering of keys throughout the following paras has reference to this chart.

5.15 The allotment of these nine characters to the nine keys in the stat row strictly in order of frequency would result in the following arrangement:—

त	स	।	क	ई	ह	र	ँ	ी
9	7	1	3	5	6	4	2	8

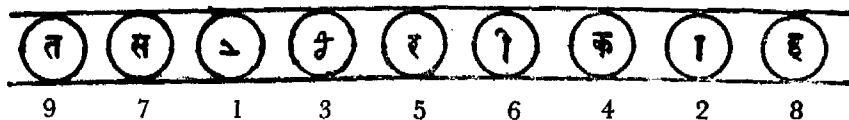
5.16 The first six keys in order of propitiousness are operated by the first two fingers of each hand, the fore-finger of each hand manipulating two keys. They have been graded in the order of relative propitiousness from one to six. Practically speaking, they are almost equally propitious and the Committee therefore felt that in allotting these six keys to the first six most frequent characters, greater emphasis should be placed on considerations other than strict frequency. As would be seen from the above allocation the matra of long ‘आ’ allotted to the first key comes for operation under the left hand. The Committee felt that since this matra is normally typed on the right hand side of characters and since it would also be associated with consonants as a ‘khari-pai’, for psychological reasons it should be operated by the right hand. This matra should therefore more correctly be placed for operation under the right hand. Therefore, the 2nd key in order of propitiousness which in this respect is practically as good as the first key, was allotted to the matra for long आ.

5.17 The matra for long ‘ई’ gets the 8th key on the basis of strict frequency. It was felt that the four matras, viz. those for long ‘आ’ short ‘इ’, long ‘ई’ and ‘ए’ were so frequent that for purposes of convenience they should be operated only by the first two fingers of either hand. But the 8th key is operated by the third finger of the right hand. Therefore to enable the typing of this matra by the first finger the Committee allotted it the 6th position and the consonant ‘ह’ occupying the 6th position was placed on the 8th key. The difference in the relative propitiousness of the 6th and the 8th keys of the home row is again negligible.

5.18 But this arrangement resulted in the 5th and 6th keys being occupied by the matra of short ‘इ’ and long ‘ई’ respectively. The Committee felt that there was a likelihood of wrong typing if these two matras were placed side by side. Therefore, the third key on the left being the next in order of propitiousness was allotted to matra of short ‘इ’ and the consonant ‘क’ was shifted from the 3rd to the 4th key and the consonant ‘र’ which was occupying this 4th key was shifted to the 5th key vacated by the short ‘इ’ matra.

As the second key in order of propitiousness was allotted to the matra of long 'अ' the matra for 'ए' was changed to the first key, which incidentally also brings it to the left side of the keyboard in conformity with the general principle enunciated in para 5.13 (b) above.

5.19 The final arrangement of characters on the first nine most propitious keys of the home row, therefore, worked out as follows:—



The Committee felt that this order of the characters, in view of the reasons mentioned above, would result in a far more convenient arrangement than the one which was obtained strictly in order of frequency of occurrence. As all these characters are very frequent and as the keys allotted to them are practically of the similar order of propitiousness, the Committee is sure that the frequency basis has not been appreciably disturbed and there would thus be no impairment of speed. On the other hand, this arrangement would result in much greater convenience for the typist which would, in turn, improve his speed.

5.20 The next five characters in order of frequency are :—

- | | | |
|------------------------|-----------------|--------|
| 1. The consonant 'य' : | Total Frequency | 3.45 % |
| 2. The anusvara 'ँ' : | " " | 3.41 % |
| 3. The consonant 'म' : | " " | 3.25 % |
| 4. The consonant 'न' : | " " | 3.11 % |
| 5. The consonant 'प' : | " " | 2.71 % |

On the basis of frequency 'य' should have been placed in the next most propitious key *viz.*, No. 10. But since the anusvara, which requires a dead key, has to be placed in key No. 10, 'य' has been shifted to the next key *viz.*, No. 11. This adjustment is necessary because it is mechanically more convenient to have the dead keys on one side of the keyboard rather than in the centre.

There is a little change in the allotment of the 12th and 13th keys also. Their order has been reversed ; 'न' has been given to the 12th and 'म' to the 13th key. This has been done inasmuch as in actual writing the 'म-न' combination is more frequent than the 'न-म' combination. Further, the propitiousness of the 12th and 13th keys is almost identical, and the frequency of occurrence of these two characters separately is also more or less the same, being 3.11 % for 'न' and 3.25 % for 'म'.

5.21 The next five characters in order of total frequency of occurrence are :—

- | | | |
|-------------------------|-----------------|--------|
| 1. The full vowel 'अ' : | Total frequency | 2.56 % |
| 2. The consonant 'ल' : | " " | 2.18 % |
| 3. The consonant 'द' : | " " | 2.06 % |
| 4. The consonant 'ज' : | " " | 1.92 % |
| 5. The consonant 'व' : | " " | 1.75 % |

These have been allotted to keys Nos. 15, 16, 17, 18 and 19 in the same order on the basis of frequency.

5.22 The next character in order of frequency is the matra for 'ऐ' (1.64 %). On a strict frequency basis it should have been placed in key No. 20. But this would have taken it in a row different from that of the matra for 'ए' and would in addition have placed in the centre of the keyboard. In accordance with our general principle as enunciated in para 5.13 (b) above, that the matra of corresponding vowels should be positioned

in the same row and should be operated by different hands, the matra for 'ऐ' has been brought to the home row and has been placed in key No. 30. Since this matra requires a dead key this positioning also avoids the placing of a dead key in or near the centre of the keyboard.

5.23 The next character in order of frequency of occurrence is matra for short 'उ' (1.53 %). The corresponding matra of long 'ऊ' occupies a much lower position in the order of frequency (.68 %) being nine positions below the matra of short 'उ'. On the basis of the principle that the matras of corresponding vowels should be put on the same row and should be operated by the left and the right hand respectively with the shorter matra on the left and the longer matra on the right, the Committee did not allot key No. 20 to the matra for short 'उ', since this key is operated by the right hand, and is also in the centre of the keyboard. The Committee, therefore, felt that it would be more appropriate to put both these matras in the third row instead of in the bottom row. The two available keys in order of propitiousness on the left hand and the right hand sides in the third row are Nos. 24 and 28. These have accordingly been allotted to the matra of short 'उ' and of long 'ऊ' respectively. This also enables the grouping of the dead keys on the left hand and the right hand side of the keyboard.

5.24 The five characters which now follow in order of total frequency are :—

- | | | | |
|---------------------------|---|-----------------|-------|
| 1. The full consonant 'क' | : | Total frequency | 1.39% |
| 2. The full consonant 'ग' | : | " " | 1.30% |
| 3. The full vowel 'इ' | : | " " | 1.03% |
| 4. The full vowel 'उ' | : | " " | 0.88% |

These 4 characters have been allotted to keys Nos. 20, 21, 22, & 23 respectively in order of their relative frequency.

5.25 As already mentioned above, the next key viz. No. 24 has been allotted to the matra of short 'उ' and key No. 28 has been allotted to the matra of long 'ऊ' (see para 23 above). Keys Nos. 25, 27 & 32 (which are the 8th, 9th and 10th keys from the left on the bottom row) have been allotted to punctuation marks as discussed in para 5.5 above. This brings us to keys No. 26 and 29. The characters next in order of frequency are 'श' (.74%), 'भ' (.67%), 'ध' (.62%), and 'थ' (.61%), 'ए' (.60%), 'ख' (.57%), and 'च' (.56%). On the basis of strict frequency and propitiousness the first two of these characters viz. 'श' and 'भ' should have been allotted to keys No. 26 and 29. But this cannot be done because we have still to provide an entire key for the letter 'च' which has been kept in both its full and half forms. Then again, since the major full vowels, 'अ', 'इ', 'उ', have been provided in the first three rows of the keyboard, the Committee has felt that it is appropriate to provide 'ए' also in these first three rows. Therefore keys Nos. 26 and 29 have been allotted respectively to 'ए' and to 'च', in order of their frequency. Incidentally, the positioning of 'ए' in the lower shift of key No. 26 groups the four major vowels in such a manner that two of them ('अ' and 'ए') are operated by the left hand and the other two (full 'इ' and 'उ' by the right hand). The matra of 'ऋ' has been treated on a different basis since its frequency is very low.

5.26 The next key No. 30 has already been allotted to the matra for 'ऐ'; and key No. 31 has to be reserved for the two signs of half 'र' whose

frequency is greater than that of 'श'. Therefore we are now left with only eight keys in the top row (Nos. 33-40) which can be operated by the touch method and to which therefore some of the main characters can be allotted.

Now the consonant 'श' forms a group with five other consonants ('ज्ञ', 'ण', 'ध', 'ब', 'क्ष') which have been kept in the keyboard in their half forms only for reasons already given in Chapter II. All these six characters have to be placed in the lower shift because of the relatively high frequency of their half forms and also because the 'khari pai' with which their full forms will have to be made, has also been placed in the lower shift (the key No. 2). The consonant 'श' with the highest frequency in this group has therefore been allotted the lower shift in the most propitious key in the top row, namely, No. 33.

The next three characters in order of frequency are 'भ', 'च' and 'य'. Their allotment on their frequency basis should have been to the lower shifts of keys Nos. 34, 35 and 36. But consonants 'भ' and 'य' have been provided only in their full forms. This is because of the negligible frequency of their half forms as compared to the frequency of their full forms (.027 % and .0055 % respectively). Now, key No. 34 to which 'भ' should have been allotted on strict frequency basis, is operated by the right hand. Key No. 36 to which 'य' has to be allotted is also operated by the right hand. The placing of 'भ' and 'य' in these two keys, therefore, would have been inconvenient for the typist. Therefore, the position of 'भ' and 'च' have been interchanged and 'भ' has been placed in key No. 35 which takes it to the left hand. 'य' remains to key No. 36.

The remaining four half characters ('ण', 'ब', 'क्ष' and 'ज') which form a group with 'श' have been allotted to keys Nos. 37, 38, 39 and 40 respectively in order of their frequency. This arrangement balances the half characters also, three of them being operated by the left hand and the other three by the right hand. The Committee feels that this distribution of the half and full characters in the lower shift of the top row will be very convenient for the typist and will also help his memory.

5.27 We are now left with two more keys of the basic keyboard. These are Nos. 41 and 42 both in the top row. Since these are the least propitious keys in the basic keyboard, the least frequent characters, viz. the full vowel 'ऋ' and 'ॠ' have been allotted to them. The frequency of full 'ऋ' is very low (.01%), the character 'ॠ' not occurring in Hindi at all, has been incorporated in the typewriter because of its occurrence in Marathi.

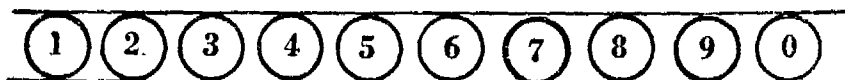
5.28 The allotment of characters to the three keys Nos. 25, 27 and 32, which are reserved for punctuation marks etc. and of two keys Nos. 30 and 31 will be discussed below. Except for these four keys, the allotment of characters to the lower shift of all the keys of the basic keyboard has been completed.

5.29 We now come to the upper shift of the basic keyboard. Here, the half forms of the 11 characters which have been provided in both their full and half forms have been placed and in the upper shift of the same key which has their full form in the lower shift. These characters are:—

- 'क' key No. 4
- 'स' key No. 7
- 'त' key No. 9
- 'न' key No. 12
- 'म' key No. 13
- 'प' key No. 14

- ‘ ल ’ key No. 16
 ‘ ज ’ key No. 18
 ‘ व ’ key No. 19
 ‘ ञ ’ key No. 20
 ‘ च ’ key No. 29

5.30 Of the remaining 31 keys of the basic keyboard the ten numerals have been provided in the upper shift of the ten keys of the top row (Nos. 33 to 42). The allotment of numerals to these keys has not been done on the basis of frequency, but they have been arranged in straight numerical order from left to right as shown in the sketch below:—



The Committee felt that any technical advantage gained by arranging the numerals in order of their frequency of occurrence will be lost by the resulting confusion and lack of order in the arrangement of numerals. Most of the English and Indian language typewriters now in use in the country also have these numerals arranged in the same straight order from 1 to 0. Typists have been long used to this arrangement and the Committee has, therefore decided to follow the same existing practice.

5.31 This leaves us with 21 keys. Of these five (viz. Nos. 25, 27, 30, 31 and 32) have been reserved for punctuation marks and other symbols etc. as discussed above. The remaining 16 keys are, therefore available for the allotment of the remaining characters. These keys can be arranged as follows in order of propitiousness:—

1, 2, 3, 5, 6, 8, 9, 10, 11, 15, 17, 21, 22, 23, 24, 26 and 28.

Out of these keys Nos. 1, 10, 24 and 28 are dead keys, hence no letters can be placed in their upper shifts. Keys Nos. 2, 3 and 6 have the matras for long ‘आ’, short ‘इ’ and long ‘ई’ respectively in the lower shift. It is therefore not possible to put any consonants in the upper shift of these keys for the obvious reason that it would be inconvenient to operate them when these consonants are combined with the corresponding matras which will happen quite frequently. This leaves us with nine keys viz., Nos. 5, 8, 11, 15, 17, 21, 22, 23 and 26. The upper shift of these keys would have been allotted to the following nine consonants on a strict frequency basis:—

‘ ख ’	Frequency	0.57 %
‘ घ ’	”	0.41 %
‘ ट ’	”	0.37 %
‘ ड ’	”	0.33 %
‘ झ ’	”	0.25 %
‘ छ ’	”	0.21 %
‘ ढ ’	”	0.12 %
‘ ठ ’	”	0.10 %
‘ झ ’	”	0.10 %

But in positioning these characters, the Committee has kept in mind the basic consideration that the character placed in the upper shift should not be such as would normally be juxtaposed with the character placed in the lower shift of the same key. Thus:—

- (i) Key No. 5 has the character 'र' in the lower shift. Out of the nine consonants mentioned above only 'ज्ञ' will not normally occur adjacently with 'र'. Hence the compound consonant 'ज्ञ' has been allotted the upper shift of this key.
- (ii) The next key is No. 8. Its upper shift has been allotted to 'ख' which is of the largest frequency of occurrence and which also does not normally occur adjacently with 'ह' the consonant on the lower shift of this key.
- (iii) The next key is No. 11. Of the consonants following 'ख' in order of frequency, 'घ' and 'ङ' are such that normally they would not juxtapose frequently with 'ख' which is the consonant on the lower shift of this key. Since 'घ' has been positioned with 'ग' (see para 6 below) the consonant 'ङ' has been allotted to the upper shift of key No. 11.
- (iv) The next available key is No. 15 which has the full vowel 'अ' in the lower shift. Of the remaining consonants which follow next in order of frequency 'उ' is the only consonant which will be least frequently juxtaposed with 'अ'. It has, therefore, been allotted the upper shift of this key.
- (v) This brings us to key No. 17, which has the consonant 'द' in the lower shift. Of the remaining consonants (viz. 'ट', 'ठ' and 'ड') none is normally juxtaposed with 'द' in the same word. As will be seen below 'ट' has been positioned with the full 'उ' with which it will rarely combine, hence the next character 'ड' has been allotted to the upper shift of this key.
- (vi) The next key is No. 21 which has the letter 'ग' in the lower shift. The consonant 'घ' has been grouped with this since it will be rarely juxtaposed with 'ग'. Hence 'घ' has been allotted to the upper shift of this key.
- (vii) The next key is 22 which has the vowel 'इ' in the lower shift. Of the remaining three consonants (viz. 'ट', 'ठ' and 'ड') the consonant 'ड' is the only one which would not normally be juxtaposed with 'इ'. The consonant 'ड' has therefore been allotted to the upper shift of this key.
- (viii) The next key is No. 23 and which has the full vowel 'उ' in the lower shift. Of the remaining two consonants 'ट' and 'ठ', the former has been allotted to the upper shift of key No. 23, since it is not normally juxtaposed with 'उ'.
- (ix) The last key is No. 26 which has the full vowel 'ए' in the lower shift. The last remaining consonant 'ठ' has accordingly been placed in the upper shift of this key, since it will not normally be juxtaposed with 'ए'.

5.32 We now come back to keys Nos. 2, 3, and 6 which have the matras of long 'आ' short and long 'ई' respectively on their lower shift. To the upper shift of key No. 2 has been allotted the special character 'शी' This character has acquired a very considerable frequency in modern Hindi, because of its common use as a honorific. Hence, it has been placed in the most propitious of these keys.

To the upper shift of key No. 3 has been allotted the multipurpose dot and to the upper shift of key No. 6 has been allotted the underlining dash. The question of the juxtaposition of these symbols with the matras in the lower shift of the respective key does not arise.

5.33 This completes the allotment of all the vowels and their matras (except that of 'ऋ') consonants, numerals, the special character 'ॠ', and the multi-purpose dot and the underlining dash in the basic keyboard. This leaves us with the following characters which have still to be accommodated in the basic keyboard:—

(a) **Matras**

- (1) The matra for 'ऋ' (̣)
- (2) The ardhachandra (̂)
- (3) The visarga (:)

(b) **Punctuation marks**

- (1) The comma sign (,)
- (2) The viram sign (।)
- (3) The hyphen sign (-)

(c) **Other signs and symbols**

- (1) The bottom dot (.)
- (2) The oblique (/)
- (3) Sign of half ॠ when last member of a conjunct. (̣)
- (4) Sign of half ॠ when first member of a conjunct. (̂)
- (5) The halant sign (̣)
- (6) The double quote marks (")
- (7) The special sign for making long (ॠ) and (ॠ) (,)

This makes a total of 13 characters. The 13 available spaces for these characters are as follows:—

Keys Nos: 1, 10, 24, 28 and 30 (upper shift only)

Keys Nos: 25, 27, 31 and 32 (both shifts)

Of these keys Nos. 25, 27 and 32 are reserved for the six punctuation marks and symbols as discussed in para 5.5 above. These punctuation and other symbols are:

- The comma (,)
- The oblique (/)
- The viram (।)
- The visarga (:)
- The hyphen (-)
- The double quote marks (")

The Committee would have liked to place all punctuation marks on the lower shift since that is their natural position. But this cannot be done as a sufficient number of lower spaces are not available. The most frequent of these punctuation marks have, therefore, been placed on the lower shift.

These are the comma (,), the viram (।) and the hyphen (-) in the same order. The comma and the viram have a frequency of .65 and .62 respectively. The frequency of the hyphen (-) sign is not given in the frequency chart of the Kalelkar Report. But independent tests conducted by the Committee showed that its frequency in modern Hindi writing was somewhat more than that of brackets. It can roughly be computed about .5%. The comma (,), the viram (।) and the hyphen (-) have, therefore, been placed in the lower shift of keys Nos. 25, 27 and 32 respectively.

The remaining three signs the oblique (/), the visarga (:) and the double quote marks (") have been allotted respectively to the upper shifts of these three keys.

5.34 The remaining seven characters do not involve a movement of the platten. Hence they have to be allotted to dead keys. We have now five dead keys (Nos. 1, 10, 24, 23 and 30) whose upper shifts are available. In addition, we have one more entire key (No. 31) which can be made dead.

As regards the positioning of these 7 characters, the main consideration with the Committee, over-riding that of strict frequency was, as before, that the character placed in the upper shift should not normally be juxtaposed with the character placed in the lower shift. With this proviso, the most frequent character among them has been allotted the most propitious key available. In order of frequency these seven characters fall in the following order :—

1. The ardhachandra.	1.06	%
2. The upper sign of half 'र'	0.86	%
3. The lower sign of half 'र'	0.69	%
4. The special sign 'ॠ'	0.48	%
5. The halant 'ँ'	0.37	%
6. The bottom dot	0.34	%
7. The matra for 'ऋ'	0.29	%

5.35 Of the first three characters, the two signs of half 'र' would be juxtaposed quite frequently with all the characters placed in the lower shift of Key Nos. 1, 10, 24, 28 and 30. Hence it has been necessary to allot them to a separate key, and the only available key (No. 31) has therefore to be allotted to them. Here the sign 'ँ' has been placed in the upper shift and the other sign has been placed in the lower shift, since these are their natural positions in actual writing.

5.36 The ardhachandra sign, besides being by far the most frequent of these six characters, will also be juxtaposed least frequently with the matra for 'र'. Hence it has been allotted the upper shift of the most propitious key No. 1.

5.37 Next in order is the special sign 'ॠ' for making 'ऋ' from 'र' and long 'ऋ' from short 'र'. On the basis of frequency it should have been allotted to key No. 10. But the lower shift of this key has the anusvara, with which it is likely to be juxtaposed quite often. The same holds good for the matras of short 'र' and long 'र' which have been positioned in the lower shift of next available keys viz. Nos. 24 and 28. Hence this sign has been placed in the upper shift of key No. 30 which has the matra of 'ॠ' in the lower shift and with which this sign will be juxtaposed least frequently.

5.38 Next comes the halant sign. The question of its juxtaposition

with any matra etc. does not arise. Hence it has been placed in the upper shift of the most propitious key available viz. No. 10.

5.39 The next character viz. the bottom dot would have been placed in key No. 24, as required by its frequency but for the fact that it will also be used as a full stop and will thus serve as a punctuation mark. Since all punctuation marks have been put on the right side of the keyboard, this character has, therefore, also been shifted to the right and placed in key No. 28. The cases where the bottom dot will be juxtaposed with the long 'ऊ' matra will be very rare.

5.40 The last remaining character, viz. the matra for 'ऋ', has been placed in the upper shift of the last remaining key viz. No. 24. The question of its juxtaposition with the matra of 'उ', which occupies the lower shift of this key, does not arise.

5.41 This completes the basic keyboard comprising of 42 keys. As stated earlier, this basic keyboard will be identical in all portable and standard typewriters.

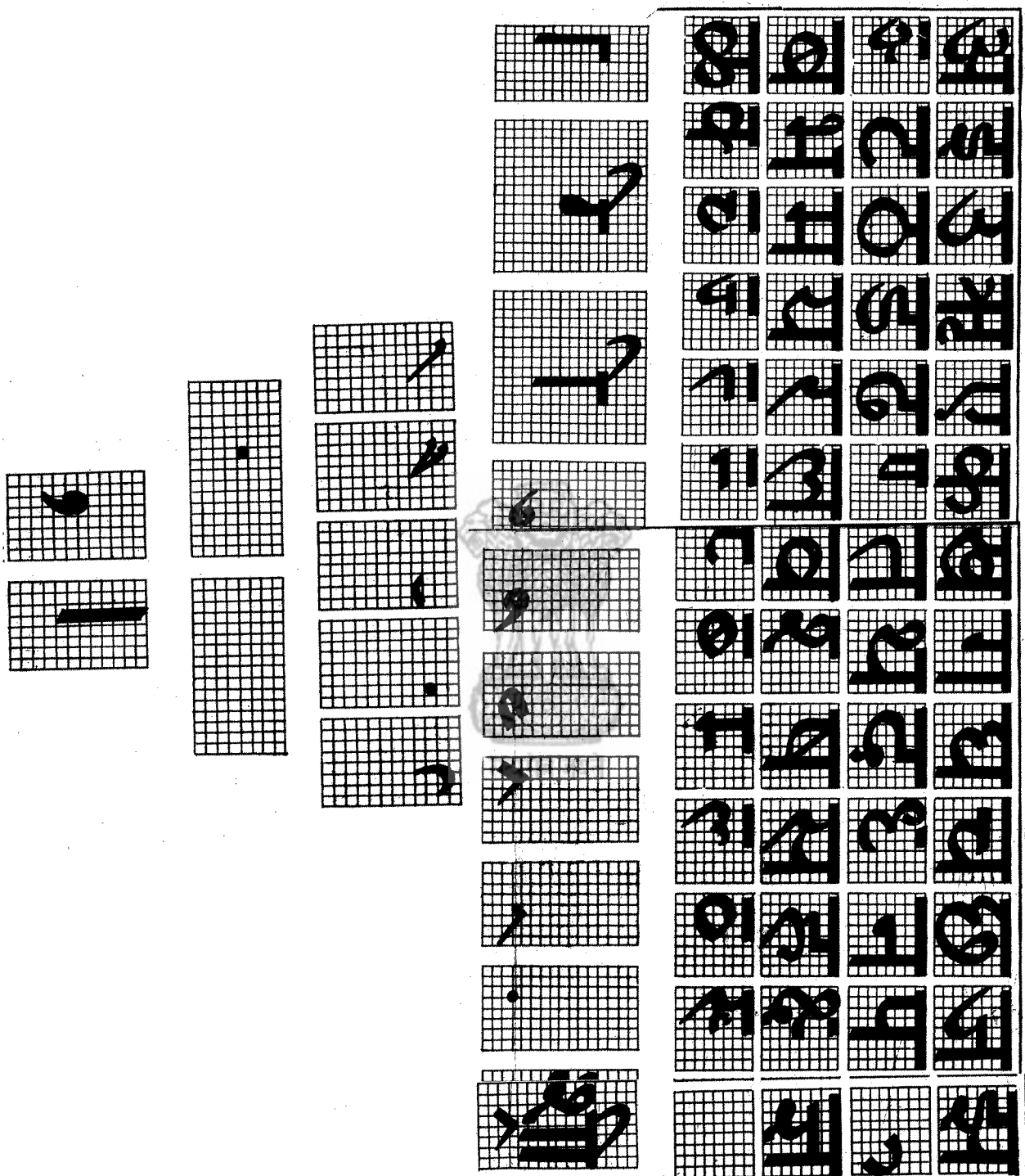
5.42 The additional four keys viz. Nos. 43, 44, 45 and 46 have been allotted signs and symbols which are not considered absolutely essential for the basic keyboard but their progressive inclusion would go on adding to the richness of the keyboard thereby increasing its utility. (see para 5.1—3 above).

5.43 The first two characters to be included with the addition of the 43rd key to the basic keyboard, are the two brackets. These have therefore been provided in this key. The opening bracket has been allotted the lower shift, and in order to ensure that a portable machine with 43 keys should have the complete set of both the opening and the closing bracket signs, the closing bracket has also been provided in the upper shift of the same key. The Committee is aware that this is a somewhat inconvenient arrangement of brackets for the typist, but it feels that the other consideration of the provision of bracket signs in as many of the portable typewriters as possible outweighs the slight inconvenience to the typist. Also, this arrangement has the advantage of providing at least one bracket sign on the lower shift key thereby reducing by half the shift change in case of the brackets.

5.44 The next punctuation mark in order of importance is the sign of interrogation (?). This has, therefore, been provided on the lower shift of key No. 44. It will not be available in portable typewriters having less than 44 keys. But in view of the comparatively low frequency of this sign, this would not materially impoverish the 42 and 43 key portable typewriters and will not hamper ordinary Hindi writing. The upper shift of this key has been allotted to the single inverted comma sign which comes next in order of importance and which, therefore, the Committee was desirous to include the 44 key-typewriter.

5.45 To key No. 45 have been allotted the percentage symbol (%) and the asterisk sign (*), since these two signs come next in order of importance. The percentage symbol has been put in the upper shift since it will always be used with numerals which occupy the upper shift. The 'asterisk' mark has been put in the lower shift and the Committee considers that this is an improvement on the existing typewriters since this mark is most often used with characters which occupy the lower shift, and its being placed in the lower shift will obviate the necessity for a shift change whenever the 'asterisk' has to be typed.

5.46 The last additional key viz. No. 46 has been allotted the two mathematical symbols—the equation mark (=) and the sign of multiplication (×). These are the least frequently used characters in a typewriter and hence



have been allotted the least propitious key. As between them, the equation mark being obviously more frequent, has been allotted the lower shift.

5.47 This completes the positioning of all the 46 characters selected for the Hindi typewriter keyboard. The keyboard as now emerges can be seen in Appendix I which shows the proposed keyboard designs with 46, keys.

5.48 It will be clear from the above discussion that a number of important principles have been followed in formulating the Hindi typewriter keyboard. The keyboard now evolved is an outcome of a reasonable and practical combination of the essence of all these principles. On the one hand, an attempt has been made to incorporate almost fully the reformed Devanagari script as approved by the Government consequent on the recommendations of the Lucknow Conference. On the other hand, the Committee, in formulating the keyboard, has tried to ensure, that it should be rich and should incorporate as many approved half forms, special symbols and punctuation marks as possible. Above all, this keyboard has been designed on the scientific principle of the frequency of the various characters and the relative propitiousness of the different keys of the keyboard, with due regard to its practical aspect from the point of view of the typist. The mechanical load has been equitably distributed among the fingers of both hands; the typist's memory has been helped as far as possible by judicious placing of allied or associated characters; the grouping of certain characters in actual words has also been kept in view; and the necessity to operate the same key twice in succession with a change of shift has been avoided as far as possible. The keyboard is thus expected to achieve the maximum possible speed, both theoretically and practically, and to permit typing with the greatest ease and convenience.



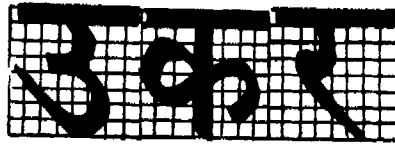
CHAPTER VI

ALIGNMENT OF CHARACTERS

6.1 The alignment of characters in a Devanagri typewriter presents certain special problems. There are character like 'क', the 'khari-pai' of which meets the 'Shirokekha' in the exact centre. On the other hand, there are letters like 'ग', 'स', 'य', 'प' which have their 'khari-pai' displaced slightly towards the right of the centre. Further, there are other letters 'ख', 'स' etc. which have their 'khari-pai', still further displaced to the right. On the other hand, there are characters which have no 'khari-pai', at all like 'छ', 'र'. Characters like 'ट', 'ढ', 'ड', 'ढ' and 'ह' have a small vertical stroke on the top which meets the 'shirokekha' not exactly in the centre but slightly to the right of the centre.

6.2 In addition to these full characters, there are half-characters which combine with full characters and also with one another. Then there are the matras and other special symbols which are placed above, below or to the right of the characters. The alignment of these different characters in a Devanagri typewriter has therefore to be such that each vowel, consonant, half-consonant, matra or other symbol, whether it is typed singly or in combination with other characters will not appear out of place and, what is even more important, will not overlap or cut into another character. In printing, this difficulty is overcome by having separate combined types for different combinations of character. But in typewriting this is not possible because the number of characters which can be incorporated in a typewriter keyboard is strictly limited. The positioning of each character on the type face of a typewriter, therefore, requires a great deal of calculation of all the combinations in which it is likely to occur, so that it is distinctly juxtaposed with other characters and does not overlap or cut into them. The alignment of characters in a typewriter, therefore, is of very great importance. The Committee has considered this problem in great detail and the exact alignment of each one of the characters included in the keyboard is given below.

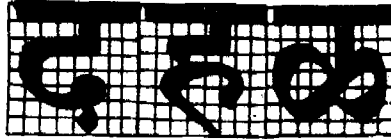
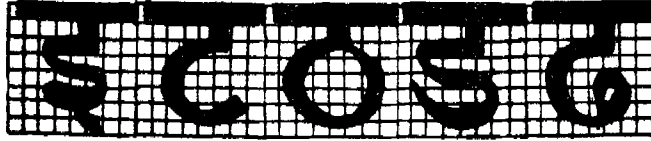
6.3 Characters which meet the 'shirokekha' exactly in the centre. There are three such characters viz., 'उ', 'क' and 'र'. Of these 'उ' and 'र' have no khari-pai. These characters have been so aligned that their top portions touch the 'shirokekha' exactly in the centre. The exact positioning and dimensions of these letters are shown in the sketch given below :—



6.4 Other characters which have no khari-pai but a small vertical stroke. These are 'इ', 'ट', 'ठ', 'ड', 'ढ', 'ढ' and 'ह'. The character 'छ' has not been included here since it has a special shape and its alignment will be discussed later on. In their case there is a small vertical stroke at the top which meets

*It will be noticed that the characters 'ट', 'ढ', 'ढ', 'ढ' & 'ह' are slightly less in length than others. This is to ensure that the matras which will be placed below them do not cut into the character.

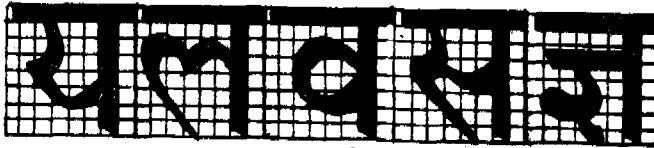
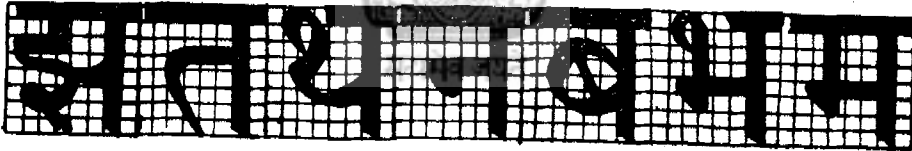
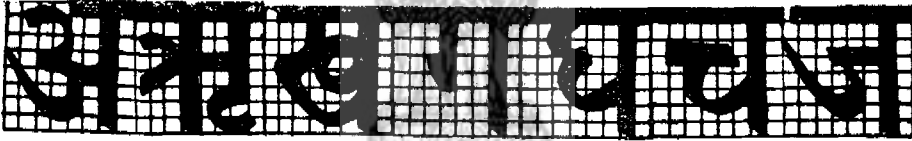
the 'shirorekha, slightly towards the right of the centre. But all of them have loops which go towards the left. To balance these characters, therefore, their small vertical stroke at the top has been displaced to the right of the centre by $\frac{1}{8}$ of the total space occupied by the letter. Their exact position on the type face and their dimensions can be known from the sketch given below :—



6.5 Full characters with a khari-pai. These are :—

अ, ऋ, ख, ग, घ, च, ज, झ, त, थ, न, ब, भ, म, य, ल, व, स, ङ*

In their case the khari-pai is appreciably to the right of the centre and the whole of the character is formed in the left of this khari-pai. These characters therefore are to be positioned on the type face that the khari-pai will be uniformly placed at a point $\frac{3}{4}$ to the right of the total space occupied by the character. The width of the characters has been suited to the shape of each character. The sketches given below illustrate the width and positioning of these characters in the type faces :—



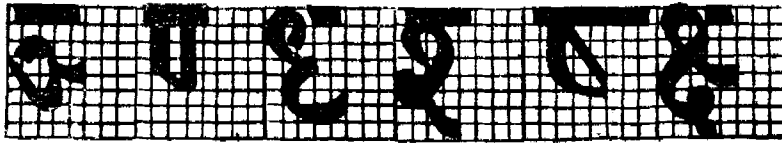
6.6 The full vowel 'ए', also forms a group with the above, since its width and length is comparable to them. It has, therefore, also been positioned in the same manner, as shown in the sketch below:—



6.7 Characters which have been provided only in their half forms. These are: ञ, ण, ध, श, ष, and झ. These half characters will combine

*The character 'ए' has not been included here because it will be dealt with as special case. See para 6.7 below.

with other characters and will also form their respective full consonants by the addition of the khari-pai. In addition, they are half movement characters. It is, therefore, necessary to position them in half the space occupied by the full letter. The position of the khari-pai which also seems as the matra of long 'अ' has been fixed in the second quarter of the left of half of the letter space (see para 11 below). These half characters (except 'उ' and 'र' have, therefore, been so shaped that their right end projects a little to the right beyond the centre. In the case of 'उ' and 'र', the entire half characters have been positioned in the centre left half of the letter space. The dimensions and positioning of these six characters is shown in the sketch given below:—



6.8 The character 'क' has to be specially treated, since it will be used to form 'क़' also, by the addition of a loop to the right of the khari-pai. In order to ensure the correct alignment of the letter, so that it would not touch or overlap the character following, the khari-pai of 'क' has been shifted slightly to the left and has been positioned just to the right of the centre of the letter space as shown in the sketch below:—



6.9 The shape of the consonant 'ग' is peculiar. It has neither a khari-pai, nor even a small vertical stroke above. Further, its top does not touch the 'shirorekha' in the centre. It starts with a small loop very much to the left of the centre. This is followed by much longer loop which goes first to the left and then sweeps right round to the right of the centre, ending in yet a third closed loop cutting across the Centre.

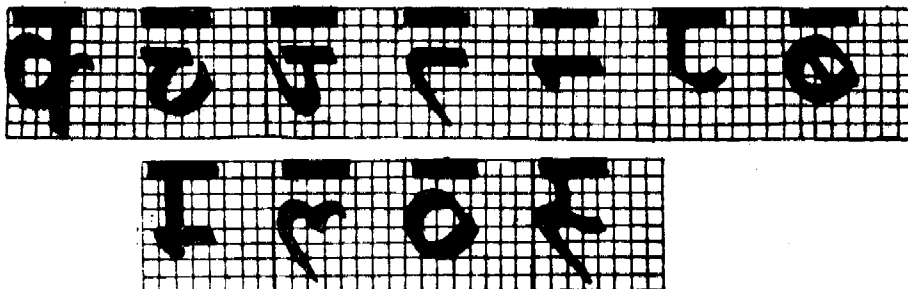
The exact shape of this letter and the positioning of the different loops is shown in the sketch given below:—



This completes the alignment of all the full vowels and consonants included in the typewriter keyboard, and also of six consonants which have been provided in their half forms only.

6.10 Eleven consonants have been provided in both their full and half forms. Their half forms will have half movement, hence the alignment of these half forms has to be slightly different from the full forms. The entire half character has, therefore, been located in the left half of the letter space, so that they should juxtapose correctly with the character following, without

overlapping or cutting into it. The dimensions and positioning of the half forms of these characters are shown in the sketch given below :—

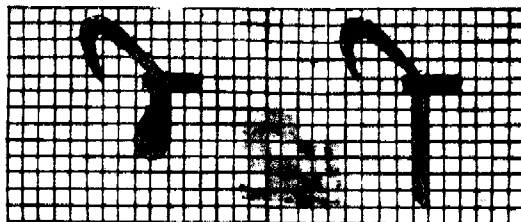


6.11 This brings us to the matras. Here, we have first to consider the matra of long 'आ'. This has to be so designed and positioned that may serve both as a matra and as a khari-pai to form full forms of those consonants which have provided in their half forms only. In addition, it has to provide the vertical stroke in the matras of 'ओ' and 'औ'. Taking all these functions into consideration and also bearing in mind that this will be a half movement character, the matra of long 'आ' has been positioned in the second quarter of the left half of the full letter space as shown in the sketch below :—



6.12 The matra for short 'इ' and long 'ई' being also half movement characters have their vertical stroke positioned in the second quarter of the left half of the full letter space, like the long 'आ' matra. In case of the long 'ऋ' matra this vertical stroke will be of the same shape and size as of the long 'ऌ' matra. In case of the short 'ऌ' matra, however, this vertical stroke will stop half way down and will then loop towards the left just touching the left side of the full letter space. This will prevent overlapping or cutting of this loop into the proceeding character.

The loop at the top, in the case of both these matras, will start from the left end of the vertical stroke and will sweep to the left rising to a distance equal to half the height of the full vertical stroke. It will then come down swerving slightly to the right meeting the 'shirorekha' in the second quarter of the right half of the previous letter. The type face will accordingly have to be off-set to the left in order to accommodate this upper loop. The shape and alignment for both these matras is shown in the sketch given below :—



6.13 The next half movement character is the ~~matra~~ ~~character~~ dot used for making 'ऋ' from 'ऌ' and a semi-colon ';' from ~~the~~ ~~character~~ ~~also~~

be used as a decimal sign. Its exact alignment on the type face is indicated in the sketch given below. The type will be off-set to the left :—



6.14 The comma has also been made a half movement character since it will be used to form a semi-colon with the multipurpose dot. Its exact alignment is shown in the sketch given below. It is so positioned that it will come exactly under the multipurpose dot, in typing :—

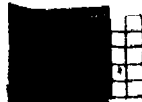


6.15 We now take up matras and symbols which require dead and off-set keys. The matras of short 'उ' and long 'ऊ' will come below the characters. As already explained above, there are letters with khari-pai in the centre, with the khari-pai slightly or very much towards the right, and still others with no khari-pai at all. The correct positioning of the matras of short 'उ' and long 'ऊ' would thus be different for these different characters. Since, however, the position of these matras cannot be varied for different characters in a typewriter keyboard, we have to find out the most suitable place where these matras can be put below the characters without appearing to be out of alignment. The Committee examined this matter in detail and after a great deal of investigation and study it came to the conclusion that the best position for the matras of short and long 'उ' was the mid-way position between khari-pai of letters like 'क' and letters like 'स'. The width of both these matras is equal to half the full letter space. The long ऊ matra has been located in the right half of the full letter space. The short उ matra has been displaced by 1/8th of the letter space to the left. The height of both these matras has been kept equal to 3/8th of the total height of the full letter space. They have been so aligned that they rise 1/16th of the full letter space above the bottom line and go down 5/16th of the full letter space below it. On this basis the alignment of these matras should be, as shown in the sketch given below:—



This alignment incidentally would also suit characters like 'ट', 'ड' etc. that do not have a khari-pai at all.

6.16 The matra of 'ऋ' is also placed below the letter. This matra is like-wise to be associated with letters with khari-pai in the centre as well as the letter having khari-pai towards the right and also with letters that do not have the khari-pai at all. Generally speaking, however, there are more letters at the vertical stroke on the right with which this matra is associated than letters with the khari-pai in the centre or with no khari-pai after experimentation as shown in the sketch below:—



The height of this matra and its projection above and below the bottom line will be the same as of the short उ matra. The upper end of this matra starts from a position slightly towards the left of the vertical

stroke of letters like 'स'. Its horizontal shift towards the centre goes beyond the position of the vertical stroke of letters like 'क' so that this would suit all letters and its position in all cases will look balanced. It has thus been positioned 1/10 of the letter space to the right as compared with short 'उ' matra.

6.17 The halant symbol will be positioned exactly like the long ऊ matra. It will have the same width and height and will occupy the same place in the letter space as shown in the sketch below:—



6.18 The sign of half 'र' when it is the second member of a conjunct consonant has to be treated specially because it is not only placed below the character, but it is also combined with the matras of short and long 'उ' which are also placed below the characters. Its alignment is, therefore, to be such that it does not overlap either of the two matras and at the same time is not so far displaced as to lose contact with the character with which it is associated. The matras of long and short 'उ' have been positioned in the right half of the full letter space. The sign of half 'र' has, therefore, been placed towards the left half of the letter space. Its projection and height are the same as that of the short 'उ' matra as shown in the sketch given below:—



6.19 This brings us to the bottom dot. It will be used for making letters like 'ड', 'ढ' etc. It will also be used for making the sign of exclamation by putting it below the exclamation punctuation mark. In addition, this dot would be made use of as a full stop. Taking all these factors into consideration it has been aligned as shown in the sketch below:—



The alignment of this character is such that it will not overlap the short and long 'उ' matras with which it will frequently combine.

6.20 We now come to matras and signs which will be placed above the letters. The matras of 'ए' and 'ऐ' will be used with various consonants which meet the 'shirorekha' at different places. The Committee, after detailed consideration, came to the conclusion that the most-suitable points where these matras should touch the 'shirorekha' will be exactly above the point where the short vertical strokes of consonants like 'ट', 'ठ' etc. meet the 'shirorekha', i.e. 5/8th to the right of the full letter space. Both these matras will rise above the 'shirorekha' to a height equal to half the height of the full letter. The second stroke of the 'ऐ' matra will be placed under the stroke of the 'ए' matra so that the over-all height of both matras will be the same. The shape and alignment of these two matras is shown in the sketch given below:—



6.21 The sign of half 'र' when it is the first member of a conjunct consonant also comes above the 'shirorekha'. It is used with and without other matras and also for making long 'रू' from short 'रु'. Therefore, in aligning this sign in the type face we have to make sure that it does not look unbalanced and that it does not overlap or cut into other matras with which it will be associated. It has, therefore, been so aligned that it will start from the 'shirorekha' at the exact point where the 'ए' and the 'ऐ' matras will meet the shirorekha. Rising from this point, however, it is deflected towards the right rising to a height equal to that of the 'ए' and the 'ऐ' matras. Its exact alignment is shown in the sketch given below:—



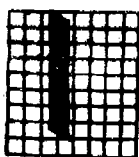
6.22. The 'anusvara' and the 'ardhachandra': Both these signs also come above the shirorekha. They will be used singly by themselves as well as in combination with each other to form the 'anunasika' sign. They will also be used in combination with other matras. Their relative position, therefore has to be such that all these combinations will be possible without overlapping. Keeping all these contingencies in view the 'ardhachandra' mark has been aligned so that it will just touch the 'shirorekha', and will be exactly above the 'khari-pai' of characters like 'स'. The 'anusvara', on the other hand, while coming exactly over the 'khari-pai' will be placed a little higher than the 'ardhachandra' so that when the two are combined they do not cut into one another. Their exact alignment is shown in the sketch given below:—



6.23. The special sign for making long 'ऊ' from short 'उ' and 'फ' from 'प' and 'र' from 'र' has been so aligned that it will fit these characters without looking out of balance. Its exact location on the type face is indicated in the sketch given below:—



6.24. The viram sign is a full movement character, but will be used to make the mark of exclamation in combination with the bottom dot. Its alignment has, therefore, to match with that of the letter, as shown in the sketch given below:—



6.25. The special character 'शी' should be of the shape and size as given in sketch below:—



6.26. This completes the alignment of the vowels, full and half consonants, matras, special sign and symbols which total 69 in number. These have been given together in Appendix 'K'.

6.27. The remaining 23 characters are:—

(a) Numerals,	1, 2, 3, 4, 5, 6, 7, 8, 9, 0	... 10
(b) Punctuation marks	/ : - ' " ?	... 6
(c) Other symbols	= × % * () —	... 7
Total		23

These characters are all full movement characters and will have their standard shapes as at present obtaining in standard English typewriters.

CHAPTER VII

INCORPORATION OF THE INTERNATIONAL AND DEVANAGRI FORMS OF NUMERALS IN THE SAME KEYBOARD

7.1 The Committee, while engaged in the task of finalising the keyboard of the Hindi typewriter, took cognisance of some controversy which had arisen regarding the form of numerals to be used in Hindi. A reference to this has been made in chapter II. As a result of the directive received from the Government the Committee conducted exhaustive investigations into the possible ways in which an additional ten characters could be included in the keyboard; so that both forms of numerals could be incorporated in it. It examined in detail the mechanical construction of the various makes of typewriters, with particular reference to their basket designs, lever clearances, key spacing etc. It held consultations with the technical experts of the leading typewriter manufacturing concerns in the country. As a result of these investigations the Committee found that while retaining the prevalent design of the typewriter keyboard with a maximum number of keys limited to 46, a second set of ten numerals could be provided in this keyboard by any of the following four methods:—

- (a) Omitting ten of the 11 half forms of consonants which have been incorporated in the keyboard and using the space so vacated for the new set of numerals.
- (b) Utilising a special mechanical device designed by Shri Ajit Singh of Patna which requires only half characters in the keyboard, the full characters being formed by the automatic typing of the 'khari-pai'. This will result in saving of 11 spaces as 11 consonants have been provided in both in the full and the half forms. These spaces could be utilised for the second set of numerals.
- (c) Use of 'clipper' type-heads:—The types associated with the top row could be of a special design so that they could be removed and new types having a different set of numerals clipped into space by the typist himself. This change of type heads being made by a very simple and quick process.

7.2 The Committee had occasion to discuss all these alternatives with the different typewriter manufacturing companies in India. At Bombay, they discussed the matter with M/s Godrej Boyce Ltd., and M/s Voltas Ltd. (who manufacture the Hermes Typewriter). At Calcutta they discussed the same problems with M/s Remington Rand and M/s Royala, the India representatives of the Halda Typewriter Company.

7.3 The first alternative i. e. dropping the ten half characters, will entail a greatly extended use of the 'halant' in forming conjunct consonants. The Committee has provided for 17 half characters. With this modification the number of half characters will be reduced to seven. Apart from the fact that the language as typed will lose its aesthetic beauty by the omission of most of the half consonants, the speed of typing also will be considerably reduced in as much as ten half consonants with a frequency of occurrence as high as 2.259 % will have to be typed by two strokes (first typing the full character then putting the halanta sign). The Committee, therefore, came to the conclusion that it would not be desirable to adopt this alternative for providing the second set of numerals.

7.4 As regards the second alternative, viz. Shri Ajit Singh's device for automatic typing of the khari pai, the Committee had detailed discussions with Shri Ajit Singh himself and also with M/s Voltas at Bombay who have prepared a prototype machine incorporating this device. The Committee had occasion to examine this prototype machine. The device is really ingenious and is so constructed that by pressing a lever before typing a character, the khari pai can be removed from the line of typing and a half character is typed. When the lever is not pressed the khari pai remains in position and the full character is automatically typed. The keyboard becomes simpler in as much as all the full characters with khari pai do not have to be provided separately and only half characters need be provided. This results in the saving of eleven spaces.

7.5 The device, however, suffers from the following mechanical drawbacks:—

- (a) The khari pai is located too near the platten. It, therefore, does not strike the platten with sufficient force to enable a number of carbon copies being taken. It also does not work satisfactorily when a stencil has to be cut. The reason is that the distance through which the khari pai type moves before striking the platten is very small and it does not acquire sufficient momentum to strike the platten with the force necessary to cut the stencil clearly or to make clear impressions on carbon copies.
- (b) The khari pai key will have to be used much more frequently than other keys, since it is typed along with every full character having the khari pai. It is, therefore, likely to get worn out quicker than other keys and also to get out of alignment. Since this key will be associated with so many characters, even a little deviation from its true alignment will result in very unsatisfactory typing.
- (c) It does not result in neat typing. Since the same character on the type face is used as a half character as well as a full character, the dimensions of the half character, are therefore larger than what they normally should be. When conjunct consonants have to be formed by using half characters of this particular shape, it is found that there is hardly any space between two adjacent consonants resulting in very congested form of typing.
- (d) As has already been discussed in Chapter IV, the Committee has recommended that the provision of half movement should be an essential feature of all Hindi typewriters manufactured from now on. With Shri Ajit Singh's device it is not at present possible to have desired half movement for certain half characters since the same half character would be used for typing a full character also.

Unless, therefore, the inventor of this device or the manufacturers who incorporate this device in their machines can overcome these drawbacks, the Committee feels that it will not be practicable to adopt this method for providing both forms of numerals in the Hindi typewriter keyboard.

On the other hand, the Committee also thinks it only fair to point out that this alternative will involve the least amount of redesigning of the existing machines and the incorporation of this device is therefore not likely to result in any appreciable increase in the cost of the machine. From this point of view, therefore, it will be worthwhile to explore further the possibilities of this device.

7.6 The third alternative, that of providing clipped-in-type faces, was suggested only by M/s Remingtons. They intimated that such type faces

had actually been used on some electrically operated commercial machines in America. The device was such that the type face could be removed by a special tool and a new type face having different characters could be clipped in place of the previous type. The whole operation of removing the existing type face and clipping on of the new type face was simple and could be performed by the typist himself in a very short time. The Committee made enquiries from M/s Remingtons whether the clipped-in type faces were giving satisfactory service when used over long periods and were remaining in true alignment. It was visualized by the Committee that it may so happen in some of the Hindi typewriters that only one type of numerals may be used throughout the life of the machine, and it was, therefore, necessary that the clipped-in type faces should give the same uniform performance throughout the life of the typewriter as other characters. M/s Remingtons indicated that they did not have any additional data on the types but they hoped that the clipped-in types would give the required service. One additional difficulty, however, in adopting this alternative would be that both forms of numerals may be required to be used in the same document. With clipped-in type faces the typing of such a document will require removal and putting back of types at very frequent intervals which will unnecessarily delay the typing work. The Committee also felt that it will be a very cumbersome arrangement for an extra set of type faces to be kept along with every typewriter. Occasions may arise when these type faces may be lost resulting in inconvenience. On the other hand, the Committee again considers it only fair to point out that this device too is very inexpensive since the cost of providing for the extra set of type faces will be very little. It also requires practically no redesigning of the existing standard machines. This alternative also has therefore potentialities and further efforts to perfect this device may yield fruitful results.

7.7 There is one other alternative, viz. that of providing a third shift on one of the top rows of the typewriter. The Committee was informed by each of the Typewriter Manufacturing Companies individually that such an arrangement is feasible. But it would require some modifications in the basic design of the existing models of typewriters. The Committee discussed this aspect with the each Manufacturing Company by going into details of the mechanical constructions of each make of machine and the changes that would be necessary to introduce the third shift. It found that the changes required were different for each type of machine and the extent of the redesigning work would vary from machine to machine. The Committee requested each one of the Manufacturing Companies to examine as early as possible the extent of redesigning that their particular machines require, and the extent to which the cost of the machine will have to be increased to provide the additional shift. The Committee is of the opinion that if the manufacturers can manage to produce machines with the additional third shift in the top row without adding too much to the cost of the machine, this alternative will be the best for the purpose in hand. It would not interfere in any way with the basic design of the keyboard as now finalised by the Committee. It will also not involve the addition of new devices of doubtful mechanical soundness, and it will open immense possibilities for the further enrichment of the Hindi typewriter keyboard since it would place at our disposal a large number of additional spaces, without any increase in the total number of keys, which could be utilised for the introduction of additional characters signs and symbols. The Committee is, therefore, of the opinion that this is the best method for introducing the second set of numerals in the keyboard.

7.8 The Committee has discussed above the various practical methods by which both forms of numerals can be incorporated in the Hindi typewriter keyboard without increasing the total number of keys and without making the cost of the machine prohibitive. Each method has its advantages and drawbacks. The Committee has indicated its preference but it feels that it would be best to leave it to the manufacturer's convenience to manufacture typewriters adopting any one of the alternatives recommended above which can give continued satisfactory performance.



सत्यमेव जयते

APPENDIX A

(See Para 2.2)

Devanagari Characters Standardised by the Lucknow Conference

A. Vowels :	अ आ इ ई उ ऊ ऋ ॠ लृ ए ऐ ओ औ अं अः	15
B. Matras	। ॲ ी ॴ ॶ ॸ ॺ ॻ	12
C. Consonants :	क ख ग घ ङ च छ ज झ ट ठ ड ढ ण त थ द ध न प फ ब भ म य र ल व श ष स ह क्ष ज्ञ ञ	36
D. Half consonants :	क ख ग घ च ज ङ ण त थ ध न प फ व भ म य ल व श ष स ह क्ष	25
E. Numerals :	१ २ ३ ४ ५ ६ ७ ८ ९ ०	10
F. Punctuation Marks :	- — , ; ! ? ।	7
G. Other Symbols :	. ^ / \ % “ ” () + × ÷ * = †	16

121

APPENDIX B

(See para 2.3)

Frequency Percentage Chart

(As prepared by Kalelkar Committee)

1.	।	8.62	32.	श	0.64
2.	क	7.46	33.	च	0.6
3.	ख	6.39	34.	ए व	.55
4.	र	4.62	35.	ख	.51
5.	ई	4.45	36.	॰	.5
6.	ह	4.22	37.	स्	.48
7.	स	4.2	38.	ओ	.46
8.	ी	3.88	39.	ई	.43
9.	य, त	3.7	40.	त्	.38
10.	म	3.5	41.	ष	.37
11.	न	3.35	42.	ट, फ	.36
12.	ो	2.9	43.	ण	.33
13.	.	2.5	44.		.31
14.	प	2.45	45.	व, ी	.305
15.	ल	2.35	46.	ह	.3
16.	द	2.19	47.	भ	.27
17.	ज	2.05	48.	ज्	.26
18.	अ	2.025	49.	ओ	.23
19.	व	1.88	50.	ब, छ	.225
20.	॰	1.65	51.	ण	.22
21.	ब	1.5	52.	ल्	.215
22.	ग	1.33	53.	भ्	.195
23.	॰	1.14	54.	ष	.18
24.	॰	1.00	55.	श	.155
25.	उ	0.9	56.	ष्	.115
26.	॰	0.73	57.	ष्	.11
27.	भ	.7	58.	ज्ञ, ठ	.105
28.	इ	.675	59.	च, ऐ क्ष	.1
29.	न	.655	60.	ख्	.0975
30.	न्	.65	61.	त्र, ढ	.09
31.	थ	.64	62.	श्च	.08

63.	:	.075	76.	ञ	.02
64.	ध्	.0655	77.	य्	.012
65.	प्	.065	78.	ह्	.012
66.	ऊ	.045	79.	क फ्	.11
67.	अं ह ट्	.04	80.	ऋ	.009
68.	द्	.039	81.	थ्	.0055
69.	ग्	.0375	82.	,	.65
70.	ङ	.0355	83.	(	0.4
71.	क्ष्	.035	84.	)	0.4
72.	व्	.034	85.	—	0.36
73.	ग	.0325	86.	र	0.62
74.	भ्	.037	87.	†	0.08
75.	ज्	.025	88.	„	1.0



सत्यमेव जयते

APPENDIX C

(See para 2.15)

Consonants included in the keyboard

1. Consonants provided in both their full and half form:
क च ज त न प ब भ ल द स 11
 2. Consonants provided in their full form only:
ख ग घ छ झ ञ ट ठ ड ढ थ द भ य 17
र ह ङ
 3. Consonants provided in their half form:
व ण ध श ष क्ष 6
-
- 34



सत्यमेव जयते

APPENDIX D

(See para 2-22)

Characters Finally Included in the Keyboard

1. Vowels	अ इ उ ए ऋ	5
2. Matras	। ङी ॠ ॡ ॢ ॣ । ॥	11
3. Consonants		
(a) Full & Half	: क च ज त न प ब म	
both	ल व स	22
(b) Full only	: ख ग घ छ झ ट ठ ड ढ	
	थ द भ य र ह ण ऌ	17
(c) Half only	: ञ ण ध श ष क्ष	6
4. The word of common address	श्री	1
5. Punctuation marks	- — , ? ।	5
6. Other symbols	: . ' / \ ^ % ' " () × * ° ¢ =	15
7. Numerals	1 2 3 4 5 6 7 8 9 0	20

9



सत्यमेव जयते

APPENDIX H

(See para 5.11)

Chart showing the total frequency of Devanagri characters selected for the Hindi typewriter keyboard

1.	।	11.62
2.	ॐ	8.93
3.	क	7.03
4.	र	4.29
5.	ॢ	4.04
6.	ह	4.92
7.	स	3.90
8.	ी	3.60
9.	त	3.52
10.	य	3.45
11.	.	3.41
12.	म	3.25
13.	न	3.11
14.	प	2.71
15.	अ	2.56
16.	ल	2.18
17.	द	2.06
18.	ज	1.92
19.	व	1.75
20.	२	1.64
21.	०	1.53
22.	ब	1.39
23.	संभव जयते	1.30
24.	८	1.09
25.	इ	1.03
26.	उ	0.88
27.	९	0.86
28.	श	0.74
29.	७	0.69
30.	६	0.68
31.	भ	0.67
32.	ध	0.62
33.	थ	0.61
34.	ण	0.60
35.	न॑	0.60

36.	ख	0.57
37.	च	0.56
38.	ण	0.51
39. ○	◌	0.48 (the sign for making फ from प)
40.	स्	0.45
41.	घ	0.41
42.	ट	0.37
43.	त्	0.36
44.	ड	0.33
45.	◌	0.29 (the matra for ऋ)
46.	क	0.28
47.	ष	0.27
48.	झ	0.25
49.	ञ	0.24
50.	छ	0.21
51.	य	0.21
52.	ल्	0.20
53.	म्	0.18
54.	क्ष	0.13
55.	ढ	0.12
56.	श	0.10
57.	ठ	0.10
58.	व	0.09
59.	प्	0.06
60.	व्	0.03
61.	ञ	0.02
62.	ऋ	0.01
63.*	◌	0.37 (the 'halant' sign)
64.†	.	0.34 (the multipurpose dot)

○ the sign for making फ from प

* the 'halant' sign

† the multipurpose dot

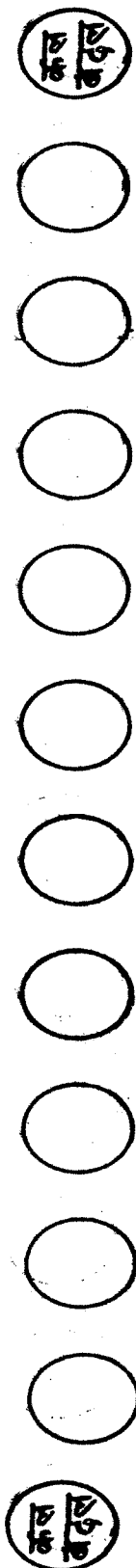
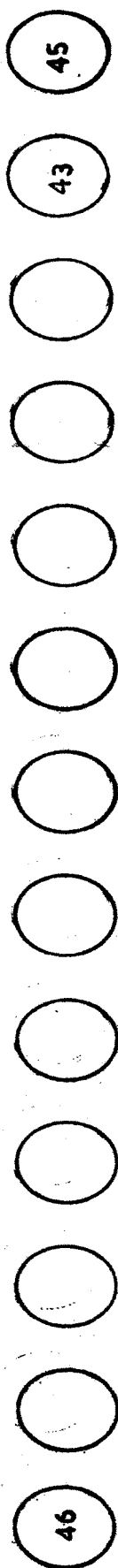
Frequencies of the following characters have not been given because special keys have been reserved for them.

- The ten numerals.
- The special signs, \times / % ' ' ' () \times * =
- The punctuation marks - , ? !
- The underlining dash, the multipurpose dot.
- The honorific 'श्री' (श्री)
- The character 'ळ'.

APPENDIX E I

PROPOSED ARRANGEMENT OF KEYS OF THE STANDARD TYPEWRITER KEY BOARD

46 KEYS TRAPEZE DESIGN (SEE PARA 3.4)

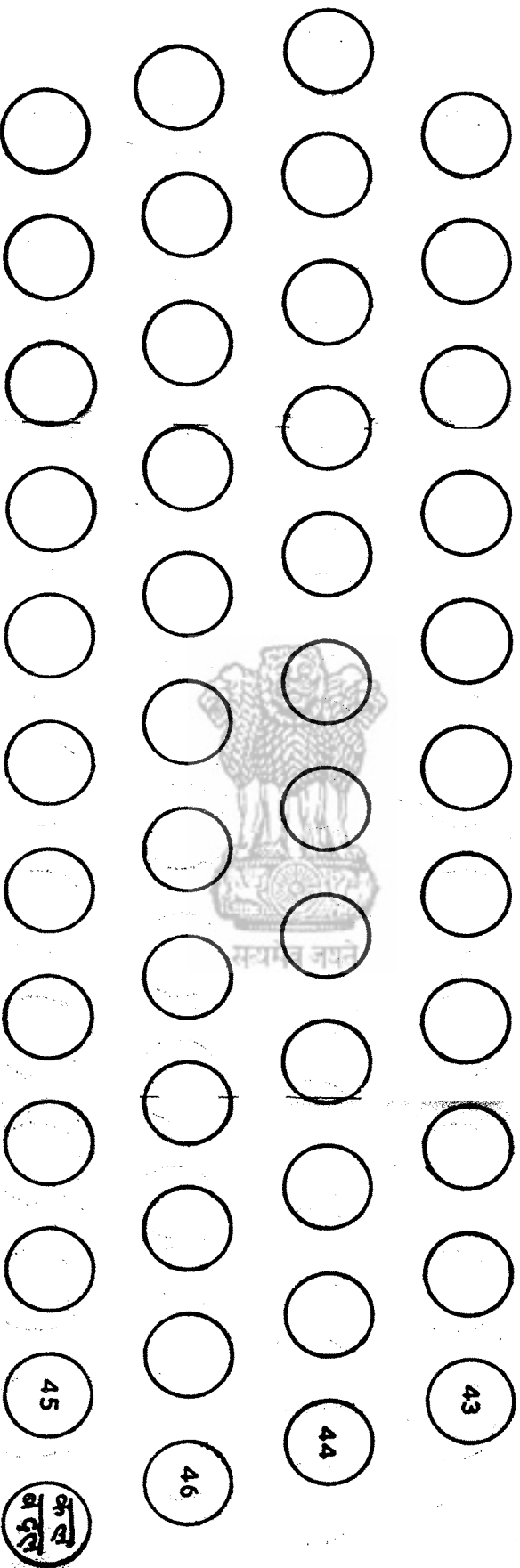


अन्तर छड़

APPENDIX E II

CONVENTIONAL ARRANGEMENT OF KEYS IN A STANDARD TYPEWRITER KEY BOARD WITH

46 KEYS (SEE PARA 3.4)



क्या
बदल

अन्तर खंड

क्या
बदल

45 KEYS (SEE PARA 3.4)

[illegible]

३-८२

APPENDIX E IV

PROPOSED ARRANGEMENT OF KEYS FOR A PORTABLE OR STANDARD TYPEWRITER WITH

44 KEYS (SEE PARA 3.4)

[illegible]

अ-२८२

APPENDIX E V

PROPOSED ARRANGEMENT OF KEYS FOR A PORTABLE TYPEWRITER WITH

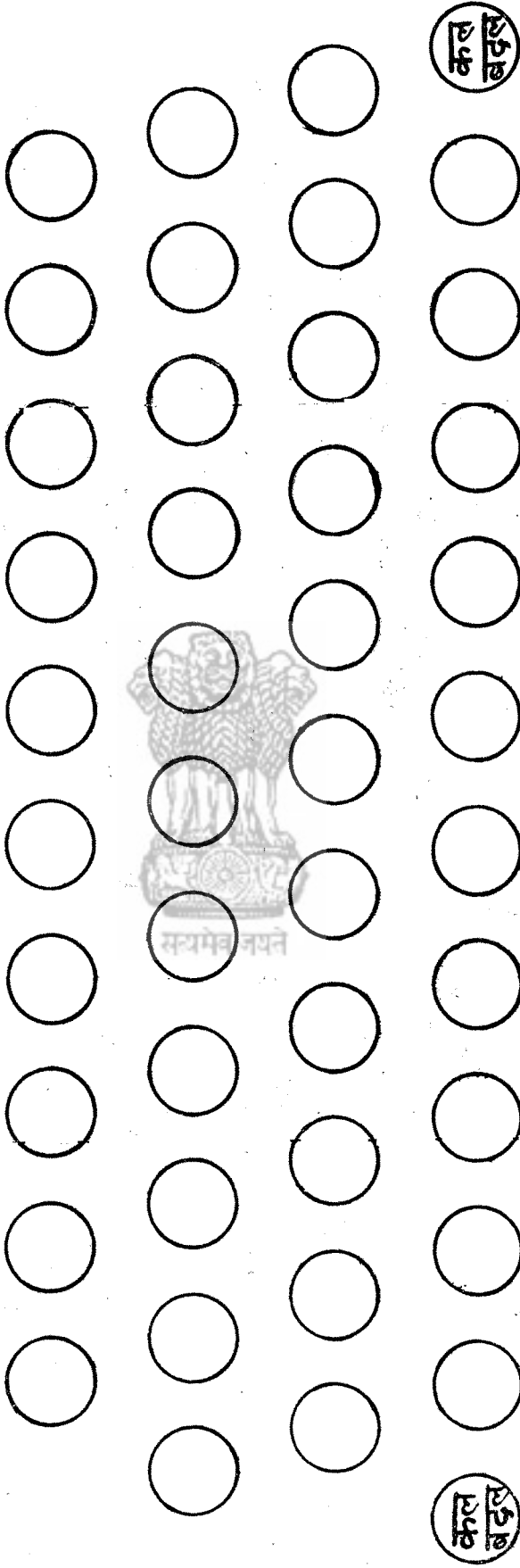
43 KEYS (SEE PARA 3.4)

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APPENDIX E VI

PROPOSED ARRANGEMENT OF KEYS FOR A PORTABLE TYPEWRITER WITH

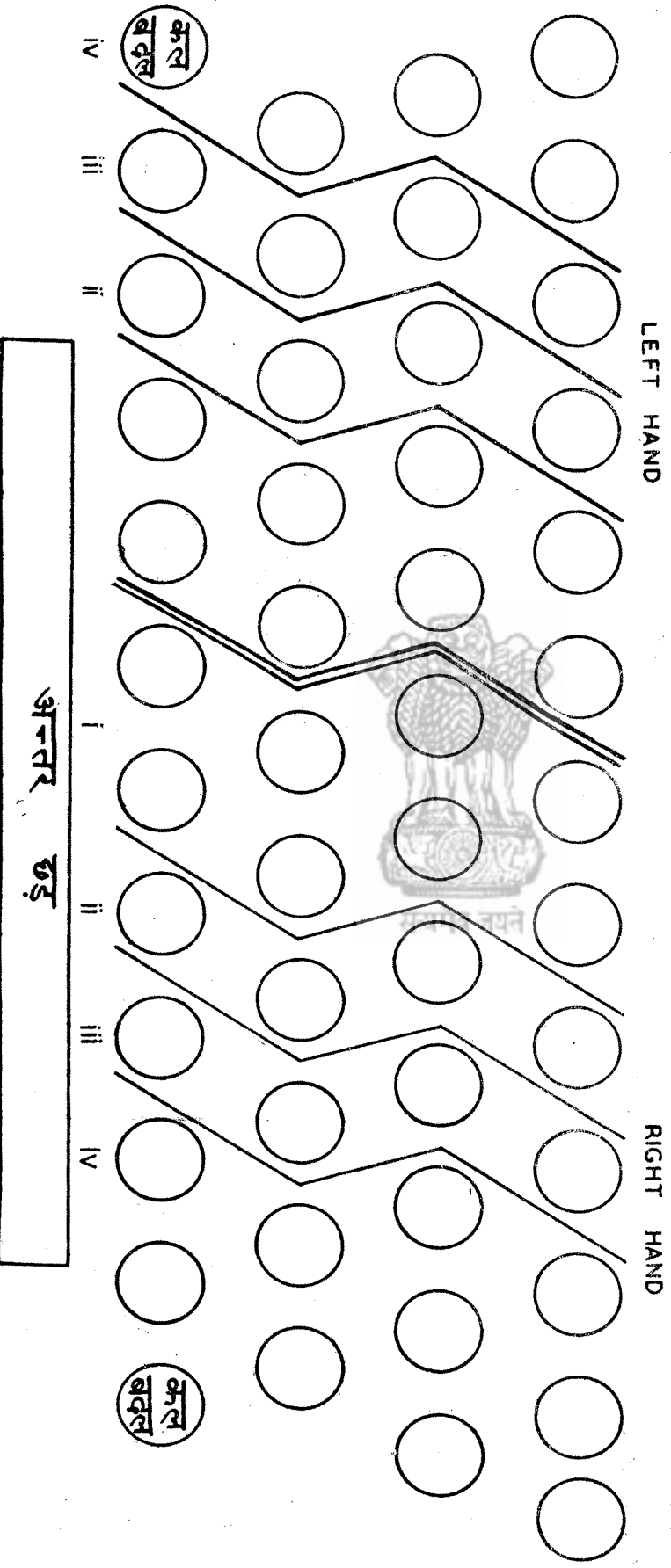
42 KEYS (SEE PARA 3.4)



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APPENDIX F

CHART SHOWING OPERATION OF KEYS BY DIFFERENT FINGERS OF THE TWO HANDS
(SEE PARA 3.5)



APPENDIX G

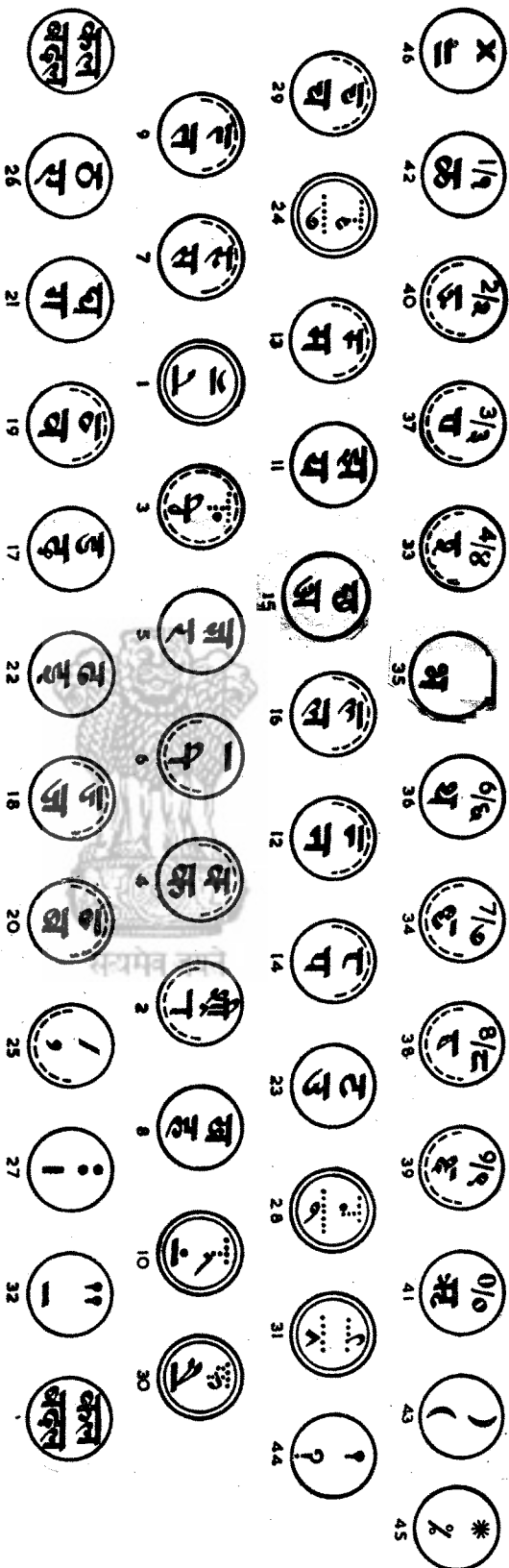
CHART SHOWING THE RELATIVE PROPOSITIONS OF KEYS ON THE PROPOSED KEY-BOARD
(SEE PARA 3.8 TO 3.17)



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FINALISED KEY-BOARD FOR THE STANDARD HINDI TYPEWRITER

46 KEYS



NOTES

DOT IN UPPER SHIFT OF KEY NO. 3 $\frac{1}{2}$ IS THE MULTIPURPOSE DOT FOR MAKING 5 FROM 5, 9 FROM 9 & TO BE USED AS A DECIMAL SIGN.

2. THE LOWER SIGN IN KEY NO.3 IS THE MATRA OF SHORT E

2. KEY HAVING HALF MOVEMENT IN UPPER SHIFT. 5. (1/2) 4. (1/2) SIGN IN UPPER SHIFT OF KEY NO. 10 (1/2) IS THE HALANT SIGN. SIGN IN UPPER SHIFT OF KEY NO. 30 (3/4) IS THE SPECIAL SIGN TO MAKE ts FROM

4. KEY HAVING HALF MOVEMENT IN LOWER SHIFT.

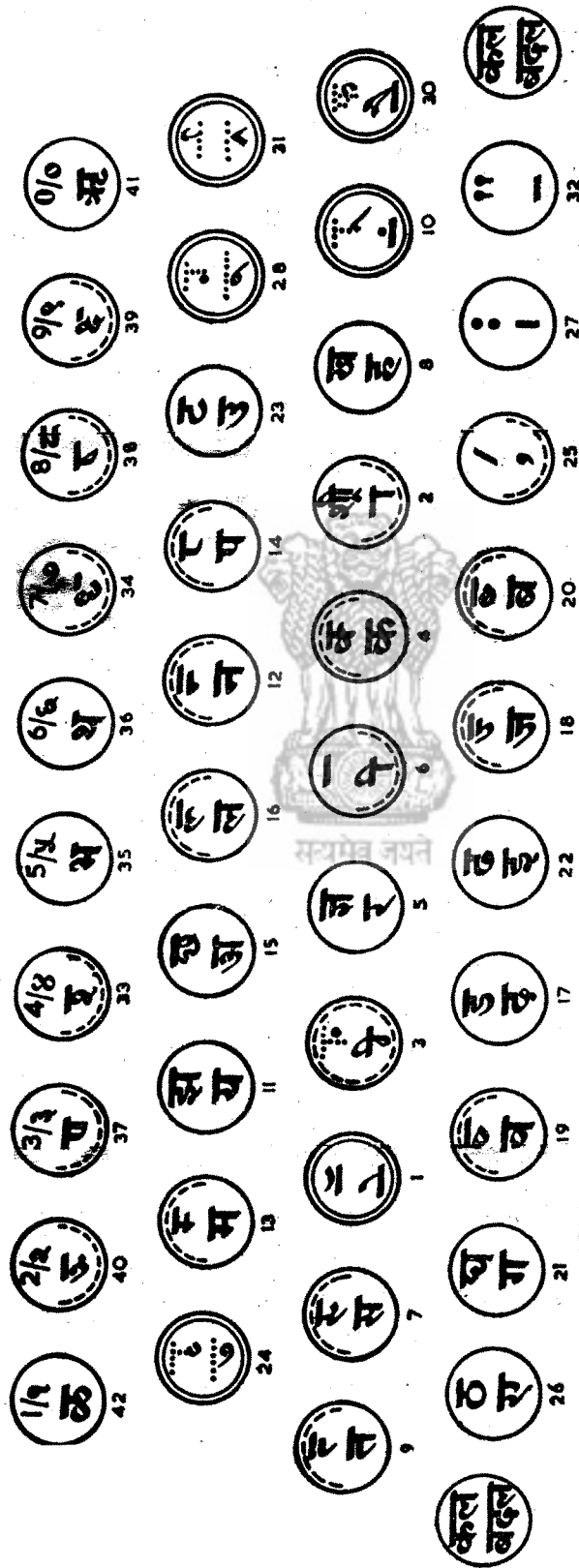
KEY MOVING HALF MOVEMENT IN LOWER SHIFT.

KEY MOVING HALF MOVEMENT IN BOTH SHIFTS. FULL CONSONANTS FROM THE HALF CONSONANTS S, T, T, T, S & H IN KEY

6. (T) MATRA OF LONG MT IN BOTTOM SHIFT OF KEY NO. 2 (T) IS TO BE USED ALSO FOR MAKING

FINALISED KEY-BOARD FOR THE STANDARD HINDI TYPEWRITER

42 KEYS



ॐ नमो भगवते वासुदेवाय

LEGEND

NOTES

- NOTES**
1. NUMBER BELOW THE KEYS INDICATE THEIR RELATIVE ORDER OF PROPTIOUSNESS.
 2. DEAD OFFSET KEYS.
 3. KEY HAVING MOVEMENT IN UPPER SHIFT.
 4. KEY HAVING MOVEMENT IN LOWER SHIFT.
 5. KEY HAVING MOVEMENT IN BOTH SHIFTS.
1. DOT IN UPPER SHIFT OF KEY NO. 3 (Ⓜ) IS THE MULTIPURPOSE DOT FOR MAKING Ⓕ FROM Ⓒ, ;
FROM 9 & TO BE USED AS A DECIMAL SIGN.
2. THE LOWER SIGN IN KEY NO. 3 IS THE MATRA OF SHORT Ⓔ
3. DOT IN UPPER SHIFT OF KEY NO. 28 (Ⓢ) IS THE BOTTOM DOT FOR MAKING Ⓓ FROM Ⓐ, Ⓑ FROM Ⓖ etc
4. (Ⓡ) SIGN IN UPPER SHIFT OF KEY NO. 10 (Ⓛ) IS THE HALANT SIGN.
5. (Ⓣ) SIGN IN UPPER SHIFT OF KEY NO. 30 (Ⓟ) IS THE SPECIAL SIGN TO MAKE Ⓞ FROM
Ⓡ, Ⓕ FROM Ⓐ & Ⓓ FROM Ⓔ
6. (Ⓝ) MATRA OF LONG Ⓤ IN BOTTOM SHIFT OF KEY NO. 2 (Ⓢ) IS TO BE USED ALSO FOR MAKING
FULL CONSONANTS FROM THE HALF CONSONANT